NEW SERIES

SELECTED

# **SESOURCES**RESOURCES ABSTRACTS



VOLUME 2, NUMBER 1 JANUARY 1, 1969

# NEW SERIES

Selected Water Resources Abstracts is published semimonthly for the Water Resources Scientific Information Center (WRSIC) by the Clearinghouse for Federal Scientific and Technical Information (CFSTI) of the Bureau of Standards, U. S. Department of Commerce. It is available to Federal agencies, contractors, or grantees in water resources upon request to: Manager, Water Resources Scientific Information Center, Office of Water Resources Research, U. S. Department of the Interior, Washington, D. C. 20240. Annual subscription is \$22.00 (domestic), \$27.50 (foreign); single copy price is \$3.00.



# SELECTED

# WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center, Office of Water Resources Research, U.S. Department of the Interior



VOLUME 2, NUMBER 1 JANUARY 1, 1969

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## UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, Secretary

#### OFFICE OF WATER RESOURCES RESEARCH

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WATER RESOURCES SCIENTIFIC INFORMATION CENTER

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#### FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifers which are listed in the Water Resources Thesaurus (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.
- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

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#### 01 NATURE OF WATER

Includes the following Groups: Properties; Aqueous Solutions and Suspensions

#### 02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

#### 03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

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# SELECTED WATER RESOURCES ABSTRACTS

#### 01. NATURE OF WATER

#### 1B. Aqueous Solutions **AND Suspensions**

THE RELATION OF HUMIC COLOR TO IRON

IN NATURAL WATERS,
Minnesota Univ., Minneapolis, Limnological Research Center.

For primary bibliographic entry see Field 05B.

For abstract, see . W69-00385

#### 02. WATER CYCLE

#### 2A. General

THE EFFECT OF CLIMATE ON DRAINAGE DENSITY AND STREAMFLOW, US Geological Survey, Water Resources Div., Washington, D. C. Charles W. Carlston. Bull of the Int Ass of Sci Hydrol, Vol 11, No 3, pp 62, 69, 1966, 8 p. 1 fig. 2 tab.

62-69, 1966. 8 p, 1 fig, 2 tab.

Descriptors: \*Climatic zones, \*Drainage density, \*Streamflow, Recharge, Precipitation intensity, Runoff, Evapotranspiration, Base flow, Groundwater recharge, Temperature, Arid climates, \*Storm runoff, \*Rainfall-runoff relationships, Semiarid climates, Arid climates, Alluvial channels, Floods, Petrography, Flow rates.

Recharge is dependent upon the amount and distribution of precipitation, less the amount of loss in direct overland runoff and evapotranspiration. Examination of the relation of drainage density to base flow in the 15 basins studied gave evidence that base flow was affected by precipitation or recharge (a climatic variable), while varying in-veresly with drainage density. Annual precipitation decreased to negligible amounts in passing through the sequence of increasing aridity in Steppe and Desert climates. Drainage density was a function of flood runoff intensity whether the magnitude of runoff intensity was due to precipitation intensity or terrene transmissibility. In semi arid and desert climates of the western and southwestern United States, recharge to the water table occurred only during exceptionally wet and cool winters or along flooded alluvial ephemeral watercourses at times of exceptional storms. These regions were characterized by extremely great variations in flood runoff and drainage density. There were great differences between the barren, angular, fine textured mountain ranges and the broad, smooth and aggrading depositional bolson floors of the intermountain basins. (Blecker-Ariz) W69-00157

TIME SERIES ANALYSIS,

U. S. Geological Survey, Arlington, Virginia. N. C. Matalas.

Water Resources Research, Vol 3, No 3, pp 817-829, Third Quarter 1967. 13 p, 28 ref.

Descriptors: \*Time series analysis. Identifiers: \*Serial correlation, \*Generating process, Hydrologic events, Stationary time series, Nonstationary time series.

A characteristic feature of hydrologic events is that they are not independently distributed in time. The degree of linear dependence between events that are K time units apart is measured by the serial correlation coefficient. This correlation, which tends to decrease with an increase in K, is attributed to storage processes in the atmosphere or within the drainage basin. The correlation measures the degree of redundancy of information yielded by each hydrologic event. This redundancy implies that statistical parameters computed from a sequence of events are less reliable than is indicated by the sequence length. Hydrologic

sequences are formulated in terms of generating models to account for serial dependence between events, to allow prediction of events at future time points, and to assess the effect of serial dependence on hydrologic studies. (Seneca-Rutgers) W69-00197

PROGRAM FOR ESTIMATING RUNOFF FROM INDIANA WATERSHEDS, PART I: LINEAR SYSTEM ANALYSIS IN SURFACE HYDROLOGY AND ITS APPLICATION TO INDIANA WATERSHEDS,

Purdue Univ, Lafayette, Indiana. D. Blank, and J. W. Delleur.

Technical Report No. 4 Purdue University Water Resources Research Center. August 1968, 179 pages, 10 tab, 49 fig, and 78 ref.

Descriptors: \*System Analysis, Input-output analysis, Hydrograph analysis, \*Rainfall-runoff relationships, Watersheds, Base runoff, Rainfall excess, Storm runoff, Harmonic analysis, Frequency analysis, Hydrologic models, Synthetic hydrology, Analog models.

Identifiers: Linear system, Impulsive response, Convolution integral, Laplace transform, Fourier transform, Input matrix, Output vector, Kernel vec-

Rainfall-runoff relations were expressed by the convolution integral. The kernel function was evaluated by Fourier transform, Laplace-Gamma and Direct methods. Three analytical examples (known kernels) were analyzed. Data of 1059 storms from 55 Indiana watersheds ranging from 3 to 296 sq. mi. were assembled. The results indicated that for a third of the storms oscillatory kernels resulted. Oscillations were not necessarily due to nonlinearities but can arise from random errors in the data. Regardless of the shape of the kernel, output reproduction was accurate. Kernels from a watershed varied from storm to storm. These differences can be described in terms of time lag and maximum ordinate, and are indicative of system nonlinearity. Grouping of dimensionless kernels according to the above mentioned parameters is the basis for a suggested method of prediction, using trend relationships between maximum ordinate and base time, and between the former and time lag. Harmonic analysis of stage recorder response was presented, with the conclusion that for all natural storms no significant signal deformation is expected. Design and construction of an electronic analog simulator for rainfall-runoff studies were described. Preliminary investigation indicated that the analog is linear and can be used to estimate response to natural storms. (Blank-Purdue) W69-00210

ANALYSIS OF HYDROLOGIC SYSTEMS, Virginia Polytechnic Institute, Blacksburg, Water Resource Center.

T.T. Chiang, and J. M. Wiggert.
OWRR Project No. A-013-VA, Water Resources
Research Center, Bull. 12, May 1968. 5 p.

\*Runoff, \*Floods, Descriptors: \*Hydrology, \*Similarities, Systems analysis.

The techniques of process dynamics analysis or frequency response analysis were applied to the response to precipitation excess of watersheds. Rectangular, impervious model basins were tested for response characteristics and the input-output (rainfall-runoff) data were manipulated to provide the standard parameters of the transfer functions. These parameters were then used in an analog simulator for a digital computer to test the transfer function. The method of analysis was also applied to natural hydrologic systems, using data from the Detroit, Michigan area, after reducing the data to that of precipitation excess and surface runoff. The conclusion of the analysis is that the method reproduces flows quite well. A nonlinear, second-order equation was found to represent the runoff of the model basins. A linear, second-order equation, in which the damping coefficient is very nearly

unity (the critically damped case), was found to be a fairly good description of the flows of natural basins. (Wiggert-Va Tech)
W69-00226

WATER POTENTIAL STUDIES OF LUNI BASIN

Central Arid Zone Research Inst., Johdpur,

Rajasthan, India. V. V. Dhruvanarayana.

Ann of Arid Zone, Vol 4, No 2, pp 99-109, Sept 1966. 11 p, 2 tab.

Descriptors: \*Groundwater, \*Surface waters, Water resources, Rainfall disposition, Temperature, Equations, \*Water balance, Climatic data, Water utilization, Reservoir storage, Rainfall-runoff relationships, \*Numerical analysis. Identifiers: India, \*Water potential.

Water potential figures obtained by different methods were compared to get reliable figures of surface and groundwater potentials of the Luni Basin. Figures of mean and maximum daily rainfall and mean and maximum temperatures up to 1950 were utilized. The methods used included Thornwaite's, Khosla's, Blaney's and Strange's. Approximately equal values of total water potential were obtained with the Thornwaite and Khosla methods and the mean value of the two was considered the probable water potential. (Affleck-Ariz) W69-00372

#### 2B. Precipitation

ANNOTATED BIBLIOGRAPHY OF ESSA PUBLICATIONS OF HYDROMETEOROLOGI-CAL INTEREST,

Weather Bureau, ESSA, Office of Hydrology.

J. L. H. Paulhus. ESSA Technical Memorandum WBTM HYDRO-6, November 1967, Second Edition, 27 p.

Descriptors: \*Bibliographies, \*Hydrology, \*Meteorology, Climatology, Clouds, Dew point, Droughts, Evaporation, Floods, Hydrologic cycle, Precipitation (Atmospheric), Radar, Radiation, River forecasting, Runoff, Snow, Storms, Stream-flow, Temperature, Water management (Applied),

Identifiers: \*Hydrometeorology, Relative humidity, Water supply forecasts.

Lists 105 ESSA publications pertinent to the joint fields of hydrology and meteorology. This bibliography is especially intended to serve the engineer raphy is especially intended to serve the engineer by bringing to his attention the publications of hydrometeorological material that he often requires. General subjects include: Climatological Observations and Data/Clouds, Liquid Water Con-tent in Storms/Dewpoints, Maximum persist-ing/Drought/Evaporation /Floods/Hydrologic Cy-cle/Networks, Hydrologic/Precipitable cle/Networks,
Water/Precipitation,
Depth-Area-Duration
Hydrologic/Precipitable
computed/Precipitation,
Analysis/Precipitation,
Excessive and Maximum Observed/Precipitation, Mean and Normal/Precipitation Measurements/Precipitation, Probable Maximum/Radar (Hydrologic Uses)/Radiation, Solar and Sky/Rainfall Frequency/Relative Humidity/ River and Flood Forecasting/River Stages/Runoff/ Snow/Station History/ Storms (thunderstorms, tropical storms, hurricanes)/Storm (thunderstorms, tropical storms, hurricanes)/Storm Surges/Streamflow Frequency Analyses/Temperature/Wat Management/Water Supply Forecasts/Wind. (Strahl-ESSA) W69-00001

TIME ANALYSIS OF RAINFALL ON AN URBAN CATCHMENT,

Auckland Univ., New Zealand.

. J. Bidwell. J of Hydrol (New Zealand), Vol 6, No 2, pp 74-79, 1967. 6 p, 3 fig.

Descriptors: \*Rainfall, \*Rainfall intensity, Rain gages, Runoff, Mass curves, \*Probability, \*Correlation analysis, Rainfall disposition.

#### Group 2B-Precipitation

For urban catchments, time of concentration, runoff, and other time parameters involved is relatively short and thus rainfall increment must be short - in this analysis it was 10 minutes. A year of 10-minute rainfall values was extracted from autographic records for Albert Park, Auckland, New Zealand. The record was analyzed in order to obtain the critical time lag which was a measure of rainfall persistence. Probability of occurrence of any rainfall event was assumed to be independent of any other event. The data was punched on IBM cards for computer use. Rank-correlation coefficient were used as a test for rainfall persistence. The length of record used was not of sufficient duration to give conclusive evidence of storm lengths or any seasonal variations. Large differences occurred in sets of data analyzed in the one-year record. Whether differences were due to seasonal changes or other factors was not readily apparent. It was intended that the analysis serve as an indication of the application of the techniques to rainfall records. Techniques used in the study could be applied to arid climates where rainfall persistence and probability of occurrence are important. (Blecker-Ariz) W69-00156

RAINFALL GRADIENTS IN WARM SEASON RAINFALL.

Illinois State Water Survey, Urbana. F. A. Huff.

J of Applied Meteorol, Vol 6, No 2, pp 435-437, April 1967. 3 p, 2 fig.

Descriptors: Rainfall, \*Rainfall disposition, Storms, Meteorology, \*Rain gages, Equations, Seasonal, \*Meteorological data, Variability.

Little quantitative information has been published on distribution of rainfall gradients in various types of storms. The purpose of the study was to provide quantitative information on rainfall gradients in warm season storms in the Midwest. Records from two dense networks of recording raingages in central Illinois provided data for the study. Two equations provided the means for obtaining quantitative estimates of rainfall in unstable, shower-type precipitation of spring to fall. The derived relationships were applicable to total storm rainfall for storm durations of 24 hours or less. Results were considered a reasonable approximation of daily rainfall relations since the storm definition resulted in most storm days having a single storm period. (Blecker-Ariz) W69-00166

METEOROLOGY OF MAJOR STORMS IN WESTERN COLORADO AND EASTERN UTAH, Weather Bureau, ESSA, Office of Hydrology. R. L. Weaver.

ESSA Technical Memorandum WBTM HYDRO 7, January 1968, 75. 40 fig, 14 tab, 12 ref.

Descriptors: Advection, Air circulation, Air masses, Climatology, Hydrology marine air masses, Meteorology, Moisture, Mountains, Orography, Precipitation (Atmospheric), Rainfall disposition, Rainfall intensity, Storms, Storm structure, Synoptics tic analysis temperature, Topography, Weather patterns, Winds.

Identifiers: Western Colorado, Eastern Utah, 500mb patterns.

Meteorology of Major Storms in Western Colorado and Eastern Utah. The 42 most intense general storms in eastern Utah and western Colorado since 1899 are studied in relation to the observed or estimated broadscale upper air circulation patterns and sources of moisture. The report summarizes individual analyses of the storms. Storms are typed by reference to the behavior of the 500-mb patterns. The role of upper Lows in transporting moisture is emphasized. Indices are developed which evaluate storm moisture, temperature and influence of topography. The relative importance to the precipitation sequence of peak moisture versus proximity of upper Lows or troughs is compared. Moisture source regions are related to storm type

and season. Local topographic effects are summarized by upper wind direction. (Strahl-ESSA) W69-00270

#### 2D. Evaporation and **Transpiration**

USE OF ATMOMETERS IN ESTIMATING EVAPOTRANSPIRATION,

California State Department of Water Resources, Sacramento.

John W. Shannon.

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR3, Pap 6120, pp 309-320, Sept 1968. 3 fig, 4 tab,

Descriptors: \*Evapotranspiration, \*Instrumentation, \*Atmometers, \*Evaporation pans, Calibration, Vegetation effects, Agricultural engineering. Identifiers: \*Crop coefficients (Evapotranspiration), Climatological data.

Studies conducted by the California Dept of Water Resources during the past 10 yr show that Livingston black and white spherical atmometers provide a practical means of estimating monthly and seasonal evapotranspiration. The difference of evaporation between the black and white atmometers is affected primarily by shortwave energy, whereas evaporation from either the black or white atmometer provides an index of the total amount of energy available for evapotranspiration. Various studies have been made, the results of which indicate that the type of background such as bare ground, dry range, or irrigated pasture has little effect upon the difference in evaporation between the black and white atmometers. Height above the ground or crop likewise has little or no effect upon the difference of evaporation. Monthly crop coefficients have been developed for some of the principal crops in the California Central Valley, which provide evapotranspiration estimates consistently as good or better as can be obtained using coefficients developed from United States Weather Bureau Class A evaporation pan data. (Knapp-USGS) W69-00105

#### THE LIMITATION OF TEMPERATURE BY **EVAPORATION IN HOT CLIMATES,**

Australia Commonwealth Sci. Indus. Thech. Org., Aspendale, Victoria. C. H. B. Priestley

Agr Meteorol, Vol 3, No 3/4, pp 241-246, May 1966. 6 p, 3 tab.

Descriptors: Temperature, Evaporation, Arid climates, \*Climatic data, \*Plant growth, Environmental effects, Soil moisture, Heat transfer, \*Heat balance, Leaves, \*Air temperature. Identifiers: \*Hot regions.

Many factors affecting plant growth and well-being are sensitive to the temperature of the plant and its environment, particularly at high temperatures. A review of data was done to see what are the general principles which govern the maximum temperatures which can be obtained in the environment of a growing plant, plentifully supplied with moisture. A resume of heat balance was given. A climatic evaluation was done for 1850 stations distributed over the land surfaces of the world. Data collected by Linacre have indicated a reversal of heat transfer between leaf and air in the vicinity of 33 deg C for thin-leaved plants exposed to bright sunshine. An alternative view advanced in the paper and supported by a climatic study was that the phenomenon was quite general and that 33 deg C represents the maximum temperature attained by the air over any extensive freely evaporating surface which is naturally exposed. (Blecker-Ariz) W69-00146

#### ESTIMATES OF POTENTIAL EVAPORATION USING ALTERNATIVE DATA IN PENMAN'S FORMULA,

Commonwealth Sci. Indus Research Org., Canber-

E. A. Fitzpatrick, and W. R. Stern.

Agr Meteorol, Vol 3, pp 225-239, 1966. 16 p, 3 fig 2 tab, 23 ref.

Descriptors: \*Evaporation, \*Radiation, Vapor pressure, Air temperature, Wind velocity, Seasonal, Instrumentation, Equations, Data collec-

Identifiers: \*Penman's formula, Australia.

At Kununurra, Western Australia which has an environment with a wide seasonal range of radiation and vapor-pressure deficit, the energy and aerodynamic components of Penman's evaporation formula were calculated daily for a year. Reference values for the aerodynamic component were calculated from wet- and dry-bulb temperatures and windspeed using a relationship defined by Penman. Total radiation and relative duration of sunshine were found to be effective alternative sources of data for the energy component. Daily Piche and tank evaporimeter data were found to be satisfactory alternatives to the aerodynamic component. The minimal instrumentation needed to determine potential evaporation was a net radiometer, Piche evaporimeter and maximum and minimum thermometers provided a suitable relation between the Piche and aerodynamic component existed. The use of inappropriate constants in the Penman formula was probably a greater source of error when determining potential evaporation than the deficiencies inherent in a particular type of instrument, e g, a sunshine recorder. (Blecker-Ariz) W69-00161

#### HYDROLOGIC PROPERTIES OF SEVERAL UPLAND FOREST HUMUS TYPES IN THE LAKE STATES REGION.

Michigan State Univ., East Lansing, Dept of

Forestry. Wade L. Nutter.

OWRR Report A-017-Mich., Ph.D. Dissertation, 147 p, 27 fig, 7 tab, 42 ref.

Descriptors: Humus, \*Forest soils, \*Evaporation, Unsaturated flow, \*Soil water, Mulching, \*Infiltration, Temperature, Humidity, Radiation, Diffusivity, Percolation, Soil water movement, Soil physics, \*Hydrologic properties, Water loss.

Identifiers: Lake States, Humus-soil complex,

Forest hydrology.

Ten sites were sampled that included a variety of soil and forest conditions and humus varients of mull, duff-mull, and mor. Rates of evaporation for undisturbed cores of the humus-soil complex, 16.5cm diameter and 25.4-cm deep, were determined in controlled environment chambers by weight loss and water redistribution by gamma radiation. The humus types were separated by their hydrologic properties into four groups, each independent of inter-site mineral soil variation. Evaporation during a 50-day period was at a continuous falling rate lower than the water transmitting properties of the humus-soil complex and the mors lost a greater fraction of the initial water content than either the mulls or duff-mulls. Water flowed against the water content gradient during evaporation in response to an assumed matric suction gradient. The F horizon ceased to lose water between 16 and 30 days but the H horizon continued to lose water at a decreasing rate for the entire period of evaporation. During simulated rainfall the F and H horizons resisted wetting and water advanced as a wetting front in the mineral soil maintaining the nonuniform shape of the initial water content profile. (Author) W69-00221

PAN EVAPORATION AND EVAPOTRANSPIRA-TION FROM CLIMATIC DATA, Utah State Univ, Logan.

Jerald E. Christiansen.

#### Streamflow and Runoff-Group 2E

J Irrig and Drainage Div (ASCE), Vol 94, No IR 2, Proc Paper 5988, pp 243-265, June 1968. 23 p, 13 tab.

Descriptors: \*Evaporation pans, \*Evapotranspiration, \*Climatic data, \*Mathematical models, Equations, Data collections, \*Analytical techniques, Temperature, Solar radiation, Wind velocity, Humidity, Elevation.

A formula was developed at Utah State University for estimating pan evaporation from extraterrestrial radiation and climatic data. This formula utilizes climatic data of the type most readily available. Tables are presented to simplify the application of the formula where electronic computers are not used. Three formulas for estimating evapotranspiration for several agricultural crops using as the principal parameters either extraterrestrial radiation, pan evaporation or measured incident radiation, together with climatic data were also presented. The planning and design of irrigation systems in arid regions requires, at the outset, an estimate of water requirements which this formula can help to supply. (Affleck-Ariz) W69-00362

EVAPORATIVE WATER LOSSES OF SOME SMALL AUSTRIALIAN LIZARDS,

Michigan Univ, Ann Arbor.

Willian R. Dawson, Vaughan H. Shoemaker, and

Univ. of Western Australia, Nedlands Affiliate Inst. Ecol, Vol 47, No 4, pp 589-594, 1966. 1 fig, 2 tab.

Descriptors: \*Evaporation, \*Water loss, Animal physiology, Arid climates, \*Metabolism, Weight, Temperature, Ecology, Environmental effects, Reptiles.

Identifiers: Australia, \*Lizards.

Three Australian lizards: Amphibolurus ornatus (agamidae), Gehyra variegata (Gekkonidae), and Sphenomorphus labillardiere (Scincidae) were compared with respect to water loss in a dry atmosphere. At 20 deg C the rates of total water loss for the unrestrained A ornatus, G variegata and S labillardieri averaged 1.9 g (100 g day) -1, 3.0 g (100 g day) -1 and 6.8 g (100 g day) -1 respectively. These figures represented evaporative water loss primarily and not metabolic activity. At 20 deg C and 30 deg C the water loss which was primarily of pulmonary origin of A ornatus averaged lower than that of the other two species. Cutaneous loss at 20 deg C comprised 70% of evaporative loss by A ornatus and G variegata and 41% of S labillardieri. At 30 deg C these percentages were lower. (Affleck-Ariz)

THE USE OF WATER BY COTTON CROPS IN ABYAN, SOUTH ARABIA,

Empire Cotton Growing Corp., Namulonge, Ugan-

For primary bibliographic entry see Field 03F. For abstract, see . W69-00367

EVAPORATION OF WATER FROM SOILS AS INFLUENCED BY DRYING WITH WIND OR RADIATION,

NADIATION, U. S. Dept. of Agriculture, Fort Collins, Colorado. R. J. Hanks, H. R. Gardner, and M. L. Fairbourn. Soil Sci Soc of Amer, Vol 31, No 5, pp 593-598, Sept-Oct 1967. 6 p, 12 fig, 3 tab.

Descriptors: \*Evaporation, \*Winds, \*Radiation, Air temperature, Soil temperature, Vertical migration, \*Soil moisture, Arid lands, Thermocline, Drying, Soil profiles, Soil water movement, \*Moisture content.

Evaporation of water directly from the soil accounts for loss of a large part of the precipitation received in arid parts of the world. A study was done to determine relative importance of tempera-

ture gradients in evaporation of water from soil. Water was evaporated from soils using wind and radiative drying that would produce different temperature gradients of various magnitudes and direction. When soils were compared for periods, absolute magnitude of the slope of the water content profile was greater at the bottom of the column for silt loam than for loamy sand or sand. The reverse was true near the soil surface. Temperature profiles for the three soils were similar and data from radiated columns showed an increase of temperature with depth from 0.5 to about 6 cm at 1 day and then a decrease with depth below 6 cm. Evaporation for the second day until the end of the run was 1.22, 0.91 and 1.41 times higher for wind than for radiation treatment of silt loam, loamy sand and sand soils respectively. (Blecker-Ariz) W69\_00378

SOIL MOISTURE RESPONSE TO SPRAYING BIG SAGEBRUSH WITH 2,4-D,

Rocky Mountain Forest and Range Experiment Station, Laramie, Wyoming. For primary bibliographic entry see Field 03F.

For abstract, see . W69-00379

THE EFFECT OF SLOPE, ASPECT AND ALBEDO ON POTENTIAL EVAPOTRANSPIRATION FROM HILLSLOPES AND CATCHMENTS,

New Zealand Dept. of Scientific and Industrial Research, Soils Bureau.

R. J. Jackson.

J of Hydrol (New Zealand), Vol 6, No 2, pp 60-69, 1967. 10 p, 4 fig, 2 tab.

Descriptors: \*Evapotranspiration, Energy gradient, Radiation, \*Solar radiation, \*Slopes, Evaporation, \*Albedo, Equations, Stream flow, Water balance. Identifiers: Catchments, Penman's formula, Aspect, \*Energy balance.

Use of a radiant energy balance appropriate to slope, aspect and albedo of a hillslope or catchment, in estimation of potential evapotrans-piration of Penman's method, was illustrated for horizontal surfaces and slopes of 10, 20, 30 and 40 degrees facing north, south, east or west and having albedos of 0.1 and 0.25. The energy-balance approach to estimation of evaporation, which is based on the principle of the conservation of energy, was discussed, using equations. Included also were solar radiation on slopes, net radiation and potential evapotranspiration. For a region with average annual rainfall of 50 to 55 inches, the data implied a considerable variation in potential annual surplus available for stream flow according to characteristics of a hill slope or a catchment area. For any particular combination of slope and aspect there was a 20% decrease in potential evapotranspiration as a result of change in albedo which occurred to a greater extent in the summer months. Slope and aspect had their greatest influence on potential evaporation at the equinox. Methods described in the study could be used to measure evapotranspiration from hillslopes and catchments in arid parts of the world. (Blecker-Ariz) W69-00381

# 2E. Streamflow and Runoff

NEW ASPECTS OF RIVER RUNOFF CALCU-LATIONS,

Pub for U. S. Department of Commerce and National Science Foundation, Washington, D. C., by Israel Prog for Scientific Transl, Jerusalem. A. G. Trestman.

Book, Transl from Russian, OTS61-11465, U. S. Dep of Commerce, 163 p, 1964. 14 tab, 54 fig, 92 ref, 3 append.

Descriptors: \*Discharge measurement, \*Stage-discharge relations, \*Stream gages, \*Gaging sta-

tions, \*Hydrographs, Streams, Flowmeters, Flow rates, Runoff, Hydrology, Hydrologic data, Methodology. Identifiers: \*USSR, Hydrometeorological service, Discharge curves.

The methods of runoff measurement and computation in use in the USSR are given in a 163-page manual covering the full range of the problems of hydrometry. Novel proposals are made concerning methodology of analyzing hydrometric data. A detailed classification of discharge curves according to their degree of instability is supported by numerous practical examples to facilitate analysis of runoff. The general categories covered are: present hydrometric methods and their short-comings; classification of discharge curves by their degree of stability; relationship between runoff and stability of discharge curves as a basis for runoff-computation methods; and the task of the hydrometerological service in organizing and supervising hydrometric work. (Knapp-USGS) W69-00084

WATER DISCHARGE DETERMINATIONS FOR THE TIDAL REACH OF THE WILLAMETTE RIVER FROM ROSS ISLAND BRIDGE TO MILE 10.3, PORTLAND, OREGON,

U. S. Geological Survey, Water Resources Division, Washington, D. C.

ston, Washington, D. C. George R. Dempster, Jr., and Gale A. Lutz. U S Geol Surv Water-Supply Pap 1586-H, 1968. 32 p, 10 fig, 2 tab, 6 ref.

Descriptors: \*Discharge (Water), \*Discharge measurement, \*Stage-discharge relations, \*Unsteady flow, \*Tidal waters, Digital computers, Mathematical models, Hydrographs, Routing, Oregon. Identifiers: Slope-discharge relations, Willamette River, Portland.

Existing limited information about the river flow at Portland is supplemented and the use of mathematical models for determining water discharge in a tidal portion of the Willamette River is evaluated. In addition to presenting flow parameters, the applicability of using mathematical models to determine the discharge for the Willamette River at Portland is demonstrated by comparing computed and observed discharges for short term records and by comparing daily computed and routed discharges for a partial water year. The routed discharges are based on summations of upland streamflows routed to Portland. Discharges computed by using the mathematical models compare satisfactorily with observed discharges, except during the period of backwater from the annual flood of the Columbia River. The flow resistance coefficients used in the models vary with discharge. Agreement of computed with routed daily mean discharges is fair; above 30,000 cfs, average differences between the two discharges are about 10% and below 30,000 cfs, computed daily discharges are consistently greater than routed discharges by as much as 25% (Knapp-USGS) W69-00112

SOME RUNOFF CHARACTERISTICS OF BRITISH RIVERS,

Hull Univ., England, Department of Geography. R. C. Ward. J Hydrol, Vol 6, No 4, pp 358-372, Aug 1968. 15 p, 8 fig, 1 tab, 5 ref.

Descriptors: \*Runoff, \*Rivers, \*Hydrographs, \*Streamflow, Rainfall-runoff relationships, Spatial distribution. Identifiers: Britain.

Runoff data available for British rivers are reviewed and general characteristics of seasonal and spatial variation of flow are outlined. Short periods of record are lacking generally, so 10 yr records are compared statistically with 25 yr records to determine their correspondence. Mean annual flows differ by no more than 10%, mean monthly extremes show only one case of greater

#### Field 02-WATER CYCLE

#### Group 2E—Streamflow and Runoff

than 10% difference, and mean monthly minima show only a few large differences between 10 and 25 vr records. Of 37 rivers studied, 29 show a low water period in summer and a maximum in winter. The remaining 8 show a slight tendency to have a secondary high in summer. Maxima occur in Dec in the northwest of Britain, but as late as March in the southeast. Mean minima occur in June in the northwest and as late as Oct in the southeast. These trends are explained by greater evapotranspiration in the south and east and less infiltration in the northwest. Rainfall, as well as runoff intensity, generally decrease from northwest to southeast. (Knapp-USGS) W69-00120

SOME THERMAL CHARACTERISTICS OF TWO RIVERS IN THE PENNINE AREA OF NORTHERN ENGLAND.

Durham Univ., U. K., Dept. of Geography. K. Smith.

J Hydrol, Vol 6, No 4, pp 405-416, Aug 1968. 12 p, 6 fig, 4 tab, 18 ref.

\*Water temperature, Descriptors: Weather data, Hydrological data, Climatology. Identifiers: River thermal characteristics, England.

Water temperature for the Wear and Tees Rivers and climatic data in the Pennine region of Northern England are compiled and analyzed. In the period of record of 4 yr, the thermal regime is compared at upstream and downstream sites on each river. River temperature and climatic data are presented graphically and in tables. The range in air temperatures is several times that of the water temperatures and the diurnal water temperature peak is progressively delayed relative to peak air temperature with distance downstream. (Knapp-USGS) W69-00124

QUALITY OF SURFACE WATERS OF THE UNITED STATES 1960: PARTS 9-14, UNITED STATES 1960: PARTS 9-14, COLORADO RIVER BASIN TO PACIFIC SLOPE BASINS IN OREGON AND LOWER COLUMBIA RIVER BASIN. U. S. Geological Survey.

U S Geol Surv Water-Supply Pap 1745, 607 p, 1968. 25 p text, 1 fig, 570 p analyses, 79 ref.

Descriptors: \*Data collections, \*Water quality, \*Surface waters, \*Colorado River Basin, \*Columbia River Basin, Temperature, Turbidity, Chemical analysis

Identifiers: \*Fluvial sediment.

Records of chemical analysis, suspended sediment. and temperature are compiled for waters of the Colorado and Columbia River Basins for 1960. The data collected at the 368 stations on 250 streams include chemical analysis reports on silica, Fe, Ca, Mg, Na, K, carbonate, bicarbonate, sulfate, Cl, F, nitrate, B, pH, total dissolved solids, specific conductance, discharge, suspended load, and particle size analyses. (Knapp-USGS) W69-00126

RECORDS OF NORTH-SIDE SPRINGS AND INFLOW TO SNAKE RIVER BETWEEN MILNER AND KING HILL, IDAHO, 1948-67,

U. S. Geological Survey. C. A. Thomas

Idaho Dep Reclam Water Inform Bull No 6, Aug 1968. 65 pp, 5 fig, 3 ref.

Descriptors: \*Springs, \*Inflow, \*Discharge (Water), \*Idaho, \*Data collections, Hydrographs, Stream gages, Flow measurement, Discharge measurement. Identifiers: Snake River, Idaho.

The average annual inflow of water to the Snake River, Idaho, between gaging stations at Milner and King Hill was determined to be 7,400 cfs during the water years 1910-1966. An estimated average of 5,900 cfs or 4.3 million acre-ft per yr issued from springs on the north bank and 1,500 cfs was from all south side sources. The spring flow is discharge from the Snake Plain aguifer which is recharged by seepage from streams flowing onto the Plain from the mountains to the north, seepage from Snake River and its tributaries, and infiltration of precipitation and irrigation water. All spring records collected from 1948 to 1967 are tabulated. A map shows locations of gaging stations and spring-measuring sites. Graphs show annual mean inflow, total spring flow, and the recharge index for the Snake River Plain. Hydrographs are drawn of spring flows, south bank inflow, total inflow, and recharge index below American Falls. (Knapp-HSGS) W69-00137

EVALUATION OF RUNOFF COEFFICIENTS FROM SMALL NATURAL DRAINAGE AREAS, Kentucky Univ., Lexington.

Carlos Fix Miller. Kentucky Univ, Water Resources Inst, Res Rep No 14, 1968. 112 pp, 25 fig, 14 tab, 36 ref.

Descriptors: \*Rainfall-runoff relationships, \*Flood forecasting, \*Runoff coefficient, \*Overland flow, \*Small watersheds, Hydrograph analysis, Peak discharge, Infiltration, Rainfall intensity, Flood routing, Rainfall disposition, Time lag, Vegetation

Identifiers: \*Overland flow prediction.

Overland flow runoff coefficients are estimated from local watershed characteristics. The Stanford Watershed Model was used as a basis for developing a simplified empirical method for predicting flood peaks and frequencies for the design of small engineering structures such as highway bridges and culverts. The overland flow may be taken as some fraction of peak rainfall intensity. The coefficients of overland flow depend on the nature of the watershed surface, the probable soil moisture content, and the rainfall intensity. To predict the resultant streamflow, each overland flow hydrograph is routed downstream to a common point. The coefficient of resultant flow depends on areal distribution of overland flow, basin shape, drainage pattern, stream velocity, stream cross section, and tributary area. Equations and graphs are given to relate exposed surface index, percent impervious area, permeability, soil depth, and slope to coefficient of overland flow. Sources of information are soil surveys, topographic maps, and air photos. (K-napp-USGS) W69-00139

AUTOCORRELATION AND SPECTRAL ANAL-YSIS IN HYDROLOGY,

Pittsburgh Univ., Pittsburgh, Pennsylvania For primary bibliographic entry see Field 06A. For abstract, see W69-00207

PROGRAM FOR ESTIMATING RUNOFF FROM INDIANA WATERSHEDS, PART I: LINEAR SYSTEM ANALYSIS IN SURFACE HYDROLO-GY AND ITS APPLICATION TO INDIANA WATERSHEDS,

Purdue Univ, Lafayette, Indiana. For primary bibliographic entry see Field 02A. For abstract, see . W69-00210

LOW-FLOW INVESTIGATIONS: TECHNIQUES OF WATER-RESOURCES INVESTIGATIONS,

U S Geological Survey For primary bibliographic entry see Field 07C. For abstract, see W69-00245

RECESSION CHARACTERISTICS OF IOWA STREAMS, Iowa Univ., Iowa City.

For primary bibliographic entry see Field 03B. For abstract, see . W69-00262

INSTANTANEOUS UNIT HYDROGRAPH RESPONSE BY HARMONIC ANALYSIS. Virginia Polytechnic Institute, Blacksburg, Water

Resource Center.

J. M. Wiggert.

OWRR Project, Report No. A-014-VA, August, 1968.5 p.

Descriptors: Harmonic analysis, \*Instantaneous unit hydrograph, Surface runoff.

The method of harmonic analysis for the derivation of instantaneous unit hydrographs was studied with reference to its applicability to surface runoff prediction. It was noted that stability of harmonic coefficients was approached, as a minimum of twenty data points were available, though more were desirable. The need for a realistic separation of runoff and base flow was indicated. Most success at obtaining realistic instantaneous unit hydrographs was had when rainfall excess was confined to one or two measurement intervals. Very good correlations of predicted surface runoff were obtained with the observed surface runoff hydrographs when these instantaneous unit hydrographs were combined with more complex patterns of rainfall excess from storms of equal, overall duration. (Author) W69-00273

#### 2F. Groundwater

THE SOLUTION OF GYPSUM AND LIMESTONE BY UPWARD FLOWING WATER. Nottingham Univ., Department of Geology, Great Britain.

Britain. R. J. Firman, and J. A. D. Dickson. The Mercian Geologist, Vol 2, No 4, pp 401-408, Aug 1968. 8 p, 3 fig, 3 plate, 2 ref.

Descriptors: \*Aquifers, \*Gypsum, \*Limestones, \*Leakage, Groundwater. Identifiers: \*Leaky artesian aquifers, Evaporites, Nottinghamshire, Great Britain.

Examples are described of gypsum and limestone which have been dissolved by upward flowing water. It is suggested that such artesian and subartesian waters are more often agents of corrosion than is generally recognized. Gypsum nodules in the Newark Series of the Keuper Marl of Nottinghamshire commonly have solution holes on their bottom surfaces. Comparable holes are not found on the top surfaces of any nodules. Water commonly flows up out of the bottoms of gypsum quarries in which similar corrosion is seen on the undersurfaces of gypsum beds. Limestone quarries show the same features. In both examples the geologic structure consists of dipping strata containing alternating impermeable and soluble beds, which is a common occurrence with limestone and evaporites. Water moves upward out of the confined aquifer through solution openings in the soluble rocks. This is a common form of aquifer leakage in many artesian systems. (Knapp-USGS) W69-00089

THE HYDROGEOLOGY OF AN INDUCED STREAMBED INFILTRATION AREA, Connecticut University, Department of Geology and Geography, Storrs, Conn. P. H. Rahn.

Ground Water, Vol 6, No 3, pp 21-32, May-June 1968. 12 p, 12 fig, 2 tab, 45 ref.

Descriptors: \*Groundwater, \*Induced infiltration, \*Glacial drift, \*Surface-groundwater relationships, Connecticut, Permeability, Pump testing, Streamflow, Observation wells, Hydrologic aspects,

Hydrogeology.
Identifiers: \*Induced recharge, \*Streambed infiltration, Vertical permeability, Horizontal permea-

bility, Eskers.

#### Groundwater—Group 2F

An evaluation is made of the hydrogeology and physical properties of an aquifer system in which induced infiltration is evident. Measurement of streamflow at 3 weirs on the Fenton River, Connecticut, shows that about 34% of the water withdrawn was induced streambed infiltration. The Connecticut University well field is in a sand and gravel ice-contact strafified drift aquifer which fills the valley 60-ft deep. Water level measurements in 30 observation wells show that cones of depression spread underneath the river and are influenced in shape by highly permeable, partly buried eskers. The water table is detached from the river in the area of influence of the wells because of the low vertical permeability of the streambed in com-parison with the high horizontal permeability of the drift aquifer. The streambed cannot recharge the aquifers in the immediate area of pumping as fast as water is withdrawn. Time-drawdown pumping tests are not affected by the river. Thus, geology has a more important effect on aquifer yield than the pure hydrologic river-well system. Production is about I mgd. Quality is very good; no chlorination is needed. Data presented in topographic and surface geologic maps, water-table contour maps, ta-bles, and sections. (Knapp-USGS) W69-00111

#### GEOCHEMISTRY OF GROUNDWATER FROM UPPER CRETACEOUS-LOWER TERTIARY SAND AQUIFERS IN SOUTH-WESTERN VIC-TORIA, AUSTRALIA,

Geological Survey, Melbourne, Australia, Mines

Department.

W69-00122

For primary bibliographic entry see Field 02K. For abstract, see .

BETWEEN UNSTEADY SEEPAGE FLOW FULLY-PENETRATING TRENCHES,

Wisconsin Univ., Milwaukee, Dept. of Mech., and Northwestern Univ., Evanston, Ill., Dept. of Civil

Gabor Karadi, Raymond J. Krizek, and Hameed

Elnagger.

J Hydrol, Vol 6, No 4, pp 417-430, Aug 1968. 14 p, 9 fig, 3 ref.

Descriptors: \*Unsteady flow, \*Groundwater move-ment, \*Drainage effects, \*Ditches, Dupuit-Forcheimer theory, Digital computers. Identifiers: Matrix computation methods.

Unsteady seepage flow between 2 fully penetrating trenches is analyzed for homogeneous isotropic porous media characteristics. The solution may be extended to a cross-anisotropic porous medium. The method uses matrix mathematics to solve a non-linearized equation derived from Dupuit-Forcheimer approximations and the replacement of partial differential equations with a system of ordinary differential difference equations. The method may easily be adopted to computers and handles complicated boundary and initial conditions as well as allowing step by step treatment of the non-linearity of the differential equation. The results calculated are in better agreement with experimental results than are results obtained by the use of linearized field equations. (Knapp-USGŚ) W69-00123

## GROUND-WATER RESOURCES OF ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA,

U. S. Geological Survey. For primary bibliographic entry see Field 03B. For abstract, see . W69-00127

## PRELIMINARY REPORT ON THE WATER RESOURCES OF THE KAHUKU AREA, OAHU, HAWAII,

W. S. Geological Survey, Honolulu, Hawaii.
K. J. Takasaki, Santos Valenciano, and A. M. Ho.
Hawaii Dep of Land and Natur Resources, Div of
Water and Land Dev, Circ C39, Nov 1966. 33 p, 16

Descriptors: \*Water resources, \*Groundwater, \*Hawaii, Rainfall, Basalts, Irrigation water, Saline water intrusion, Runoff, Isohyets, Ephemeral streams, Hydrographs.

Identifiers: Kahuku area, Oahu, Hawaii, Dike water, Potential water sources.

Groundwater is the source of all the water used in the Kahuku area because the rainfall, which ranges from 30 in, on the coast to 300 in. in the mountains, infiltrates rapidly and very little of the aggregate precipitation of 273,000 acre-ft per yr runs off. Most streams are perennial in the high parts of the area and some are perennial in their middle reaches where they are fed by groundwater discharge. Most streams are ephemeral in their lower reaches. In a 2-3 mile wide zone along the crest of the mountains, groundwater is impounded by basaltic dikes. Water levels in dike impoundments range from 10-1,000 ft msl. The water moves parallel to the dikes as well as through and over them. In coastal areas, basal ground water levels are within a few ft of sea level. Numerous wells tap the basal groundwater to irrigate sugar cane. Total groundwater draft is 29 mgd. There is some salinity increase from sea water intrusion and return of irrigation water. (Knapp-USGS) W69-00130

#### PRELIMINARY REPORT ON THE WATER RESOURCES OF THE KAU DISTRICT, HAWAII,

U. S. Geological Survey, Honolulu, Hawaii. Dan A. Davis, and George Yamanaga. Hawaii Dep of Land and Natur Resources, Div of Water and Land Dev, Circ C27, Oct 1966. 25 p, 7 fig, 5 ref.

Descriptors: \*Water resources, \*Groundwater, \*Infiltration, \*Hawaii, Rainfall, Perched water, Basalts, Saline water intrusion, Runoff.
Identifiers: \*Volcanic terrane, Kau area, Hawaii.

Groundwater and rainwater caught on roofs and rainsheds are the only water sources in the Kau area, which includes the slopes of Mauna Loa, Hawaii, because infiltration of the 15-125 in. annual rainfall into the highly permeable lava flows, ash, and tuff is so rapid that no streams are perennial. Groundwater is discharged principally from springs near the shore at the outcrop of the basal groundwater body; (visible spring discharge is 30-50 mgd). The basal water is brackish for a considerable distance inland in most of Kau. Pumpage is less than 3 mgd. Perched water occurs in lava flows in the uplands from Pahala to Naalehu and discharges in springs, seeps, and numerous waterdevelopment tunnels. Average total tunnel flow is 1-2 mgd, and many tunnels are abandoned because the water was used to flume cane, which is no longer done. A thick body of high-level groundwater is impounded to 230 ft above sea level by an undetermined geological structure near Pahala. A shaft with drilled wells taps the reservoir and about 1.5 mgd is pumped but the extent and potential yield of the reservoir are not known. (Knapp-USGS) W69-00131

# ON THE INFLUENCE OF THE POLDERING OF LAKE TOGO-IKE FOR THE TOGO HOT SPRING GROUP, Japanese Society of Limnology, Otsu, Japan.

For primary bibliographic entry see Field 02H. For abstract, see . W69-00132

## PHYSICAL PRINCIPLES OF WATER PER-COLATION AND SEEPAGE, Technion-Israel Institute of Technology, Haifa,

Faculty of Civil Engineering. For primary bibliographic entry see Field 08B. For abstract, see . W69-00135

WATER RESOURCES AND SURFICIAL GEOLOGY OF THE HOMER AREA, SOUTH-CENTRAL ALASKA, AND SURFICIAL

U S Geological Survey. Roger M. Waller, Alvin J. Feulner, and Donald A Morris.

U S Geol Surv Hydrol Invest Atlas HA-187, 1 sheet, 1968. 3 map, 1 photo, 1 tab, 2 chart, 9 ref.

Descriptors: \*Water resources, \*Surface waters, \*Groundwater, \*Water quality, \*Hydrogeology, Aquifers, Hydrologic data, Logging (Recording), Water levels, Springs, Water sources, Water yield, Specific capacity, Alaska.
Identifiers: Homer, Alaska.

The groundwater resources of the Homer area, at the southern end of the Kenai Peninsula, Alaska, are described. The use of surface water is not practical because of insufficient flow in nearby streams and long distance to an adequate supply. Most of the wells drilled into Cretaceous Kenai Formation at the lower altitudes yield less than 10 gpm. The largest recorded specific capacity was 0.25 gpm per ft. On top of the 1100 ft high escarpment north of Homer, wells in the Kenai Formation yield 50-100 gpm with a specific capacity of 1 gpm per ft. Quaternary sands and gravels yield about as much water as the Kenai Formation. No fresh water is available under Kenai Spit, where most of the area's industry is located. Groundwater is of the Na-Ca-bicarbonate type with as much as 30 ppm Fe and some combustible gas. Additional development of groundwater north of the escarpment seems feasible. The water in test holes is of good quality and contains 1-2 ppm Fe. Maps scaled 1:63,360 show location of wells and springs, water quality, and surficial geology. A cross section shows relative position of major physiographic and geologic units. (Knapp-USGS)

#### THE RELATIONSHIP OF FLOODING AND SALINE WATER TABLES,

S. T. Smith.

Western Australia Dept of Agr J, Ser 4, 7 (s), pp 334-335; 338-340, August 1966. 5 p, 4 fig, 2 photo.

Descriptors: \*Flooding, \*Saline water, Groundwater movement, \*Water table, Base flow, Aquifers, Underground streams, Land clearing, Surface drainage, Valleys, \*Saturated soils, Bores, Water properties, Water pressure, Confined water,

In Western Australia there are several ways in which salt manifests itself. The most serious and extensive of these is in the valley systems where shallow saline water tables occur. This type of salt problem is called 'valley waterlogging' and occurs in most of the flat valleys throughout Western Australia. Underground water movement studies were carried out in seven valleys. The studies consisted of drilling bores to various depths both across and down each valley to tap the underground water. Four areas of water characteristics were determined when the potential pressure of the water was measured. The aspects studied were: whether the water was confined, seasonal fluctuation of the water table, continuity of underground aquifers and the direction of flow. Studies indicated that it is the water entering the higher country and passing beyond the reach of plant roots and seeping into the valley that causes water tables. Water tables did not arise from flooding. Clearing the land had greatly accelerated rising water tables. Surface drainage would have little or no effect on rising water tables. (Blecker-Ariz) W69-00159

#### RADIOMETRIC STUDIES OF THE FLORIDAN AOUIFER.

Florida State Univ., Tallahassee, Florida. J. K. Osmond, and B. F. Buie. Office of Water Resources Research, Project Completion Report A-005-FLA July 1968. 40 pp, 9 fig, 1 tab, 30 ref.

#### Field 02—WATER CYCLE

#### Group 2F-Groundwater

Descriptors: \*Uranium radioisotopes, \*Tritium, \*Florida, \*Groundwater movement, Gravity studies. Seismic studies, Groundwater recharge, Aquifer, Radioisotopes.

Research under grant A-005-FLA of the Office of Water Resources Research has been concerned with three aspects of the Floridan aquifer near Tallahassee, Florida: (1) Data on the concentration of uranium and the variations of uranium isotopes (U-234/U-238) provide a method of estimating quantitatively the volumes of sources contributing to the aquifer. Both the techniques of isotopic analysis and method of data analysis have been developed to the point where general application to hydrologic problems seem desirable; (2) Data on the tritium content (H-3) of aquifer water can be used to study time dependent problems of infiltration and aquifer flow. More analyses are needed to complete this type of study, but a new liquid scintillation counting approach (conversion to benzene) has been developed; (3) The results of a study by geophysical methods of the aquifer strata were inconclusive in the case of seismic refraction, but gravimetric traverses suggest that information may be obtained concerning faults and caverns in the limestone aquifer. (Authors)

#### SUMMARY REPORT ON THE GROUND-WATER RESOURCES OF THE ANYANG CHON BASIN.

U S Geological Survey. For primary bibliographic entry see Field 04B. For abstract, see . W69-00239

#### GROUND-WATER RESOURCES OF SAN JACINTO COUNTY, TEXAS,

U S Geological Survey. For primary bibliographic entry see Field 04B. For abstract, see . W69-00240

#### ROLE OF GROUND WATER IN TEXAS WATER PLAN,

Texas Water Development Board, Austin. For primary bibliographic entry see Field 04B. For abstract, see . W69-00250

#### **UNCONFINED AQUIFER CHARACTERISTICS** AND WELL FLOW,

Engineering-Science, Inc., Oakland, Calif., and California Univ., Davis

Houshang Esmaili, and Verne H. Scott. ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5872, pp 115-136, Mar 1968. 22 p, 6 fig, 3 tab, 25 ref.

Descriptors: \*Groundwater movement, \*Unsteady flow, \*Aquifer characteristics, Hydraulic conductivity, Storage coefficient, Darcys law, Dupuit-Forcheimer theory, Injection wells, Withdrawal. Identifiers: Unsteady radial flow.

Numerical solutions are developed for determination of aquifer characteristics and unsteady radial flow through injection wells in unconfined aquifers under constant drawdown and injection pressure conditions. These solutions are based on a numerical solution of the basic differential equation of flow. Appropriate dimensionless parameters are introduced to transform the basic differential equation of flow into an explicit form. Dimensionless graphical solutions are presented for the rate and accumulative volume of discharge and recharge and the radius of expansion of recharge mounds versus time for a range of draw-down and injection pressure values. Numerical examples are presented by applying these solutions to hypothetical field conditions. (Author) W69-00251

# CLIMATE AND STREAMFLOW OF PUERTO

RICO, U. S. Geological Survey, San Juan, Puerto Rico, Water Resources Division.

For primary bibliographic entry see Field 03B. For abstract, see . W69-00253

#### PROGRAMMING FOR PAVLOVSKY'S GROUND-WATER PROBLEM.

Oklahoma Univ., Norman.
George T. Papadopoulos, and Joakim G. Laguros. ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5840, pp 49-56, Mar 1968. 8 p, 6 fig, 1 tab. 4 ref.

Descriptors: \*Groundwater movement, \*Seepage, \*Digital computers, \*Computer programs. Aquicludes, Water level fluctuations, Irrigation, Drainage.

Identifiers: Pavlovskys method, Kuo method.

The amount of seepage and the free surface profile in an unconfined flow between two water bodies above an inclined impervious layer are highly dependent on the normal depth of flow. Pavlovsky's solution requires a rather time-consuming graphical method of calculating the value of the normal depth. The computer program presented not only reduces the time element but it also encompasses the rising surface and falling surface types of flow for values of slope greater and less than zero and for a range of headwater and tailwater values. This is made possible by using Kuo's method of false position, which is uniquely adapted to problems where the unknown function is expressed unavoidably in terms of the same unknown parameter. Variations in the length of the impervious medium are considered and 1 example is presented. (Author) W69-00263

#### GEOLOGICAL STRUCTURE AND ITS EFFECT ON THE GEOTHERMAL HYDROLOGY OF SOUTHWESTERN HREPPAR, ICELAND,

Cornell Univ., Ithaca, N. Y., Geol. Sciences Dept. George A. Kiersch, and L. N. Chaturvedi. OWRR Project No. A-020-NY, Cornell Water Resources and Marine Sciences Center, August,

Descriptors: \*Geological structures, \*Geothermal hydrology, Hot springs.

The report is a summary of results of a field investigation on geothermal hydrology in southwestern Hreppar, Iceland. A Ph.D. thesis in preparation will discuss in detail the structural pattern and the mechanism by which it controls the lo-calization of hot springs. The investigations to date indicate the following results: (1) most of the water at boiling temperatures occurring as hot springs in southwestern Hreppar is meteoric in origin; (2) the water circulates through a system of faults and through permeable zones between basalt flows, the water moves to several thousand feet below the surface and is heated by abnormally high geothermal gradient; (3) rise of this heated water back to surface is carried out again through a system of faults which slowly enlarge into convection conduits; and (4) the localization of hot water in the form of hot springs is controlled by a system of faults which are aligned in three major directions. (Neno-Cornell) W69-00309

#### DRAWDOWNS DUE TO PUMPING FROM STRIP AQUIFERS,

Pakistan Irrigation and Power Dept., Lahore. S. M. H. Bokhari, J. K. Strachan, and A. K. Turner.

J Irrig and Drainage Div (ASCE), Vol 94, No IR 2, Proc Paper 5981, pp 233-242, June 1968. 9 p, 4 fig, 1 tab. Melbourne Univ., Parkville Australia Affiliate Inst.

\*Drawdown, Pumping, Descriptors: Descriptors: \*Drawdown, Fumping, Weils, \*Aquifers, Recharge, Equations, \*Permeability, \*Theoretical analysis, Analog models, Boundaries (Surfaces), \*Membranes, Mathematical models. Identifiers: \*Strip aquifers, Membrane analogs.

Drawdown patterns due to pumping from wells in long narrow (strip) aquifers were dependant mainly on the type of side boundary (recharge, impermeable). A theoretical solution was developed for an idealized confined aquifer with impermeable boundaries, and the results compared favorably with those obtained from complimentary tests using a membrane analog. Solutions were also given for a simpler case of recharge boundaries. Either the mathematical or membrane solutions are thought to be suitable for field purposes. (Affleck-Ariz) W69-00377

#### 2G. Water in Soils

SOME PROBLEMS OF SOIL HYDROLOGY, Academy of Sciences, USSR, V V Dokuchayev Institute of Soil Science.

Yu F Gotshalk

Pochvovedeniye, No 11, pp 100-106, Nov 1967. 6 p, 5 tab, no ref. Soviet Soil Science, Transl by p, 5 tab, no ref. Soviet Soil Science, Trais. Scripta Technica, Inc, pp 1520-1526, Aug 1968.

Descriptors: \*Soil investigation, \*Crop production, \*Soil moisture, \*Methodology, Percolation, Permeability, Translations.
Identifiers: \*Soil hydrology, \*USSR.

The practical and theoretical significance of soil hydrology is briefly reviewed in relation to the effect of soil moisture on crop productivity in the USSR. Experiments were conducted on the percolation of water through dead roots of lowland peat soils, silty clays, and soils with manure and other organic additives. Results are graphed of an experiment with earthworms in connection with the application of organic fertilizers. The data indicate that soil of the heavily manured plot was more friable and more permeable to water. Also re-ported are: study on soil supersaturated with water in the vicinity of the Carpathians, and some characteristics of the water regime of soil in an area of excessive wetness. It is concluded that since soil moisture and water reserves of the soil are so variable soil hydrology problems are strictly of zonal character and cannot be evaluated on a unified basis. (Llaverias-USGS) W69-00103

#### THERMAL-GRADIENT TRANSPORT WATER IN SANDY SOILS, Academy of Sciences, USSR, V. V. Dokuchayev

Institute of Soil Science. N. F. Kulik

Pochvovedeniye, No 11, pp 86-98, Nov 1967. 13 p, 9 tab, 3 fig, 11 ref. Soviet Soil Science, Transl by Scripta Technica, Inc, pp 1507-1519, Aug 1968.

Descriptors: \*Water conveyance, \*Sands, \*Thermal radiation, Arid lands, Porosity, Translations. Identifiers: \*USSR, \*Thermal diffusion, Temperature fluctuations, Soil hydrology.

In an investigation of the water regime of sandy terrain areas of southeastern European USSR, the thermal-gradient transport of water in soils (thermal diffusion) is briefly discussed. This study involved two phenomena of seasonal and daily soil temperature fluctuations resulting from changes in solar heat received by the earth. Experiments indicate that because of temperature gradients moisture moving in the aeration zone of sand and sandy soils can be utilized by plants. Most plant root systems are located within the zone of influence of the daily temperature fluctuations, where maximum values of water transport are observed. In an arid zone conditions in sand offer wide seasonal and daily temperature fluctuations, and favor utilization of soil moisture. When the temperature difference per cm of the profile is 1C,

the range of change in thermal-gradient water transport in sand and sandy soils is 0.0130 to 0.0150 mm/hr with moisture contents from twice the wilting percentage to the minimum moisture capacity. (Llaverias) W69-00113

THE THEORY OF ABSORPTION IN AG-GREGATED MEDIA.

CSIRO, Camberra City, Division of Plant Industry. J. R. Philip.

Australian J Soil Res, Vol 6, No 1, pp 1-19, July 1968. 19 p, 5 fig, 4 tab, 23 ref.

Descriptors: \*Absorption, \*Porous media, \*Aggregates, \*Soil water movement, \*Soil properties, Laplaces equation, Darcys Law, Porosity, Permea-

The theory of absorption in unsaturated aggregated media is developed to provide a means of studying the applicability of diffusion analysis to transient flows. An aggregated medium is regarded as one made up of macroporosity, through which flow on the Darcy scale occurs, and microporosity, which is free to exchange water with the macroporosity. Absorption is analyzed with the aid of 2 extreme models of macropore flow, one a wet-front model and the other a linearized model. It is found that there is little difference between the solutions for the 2 models. The wet-front model is chosen for further study since it appears to be more realistic and is mor versatile. All models (and general physical considerations) indicate that the aggregated medium behaves initially as a classical medium with sorptivity equal to that of the macroporosity S, and the apparent sorptivity increases with time, ulimately approaching a limiting value greater than S. The cumulative uptake into the microporosity appears to be proportional to time initially, but is finally proportional to the sq root of time. It is concluded that diffusion analysis may usually be applied to aggregated media. Means of analyzing the aggregates of low sorptivity, are also provided. (K-napp-USGS)
W69-00115

SEEPAGE FLOW BETWEEN UNSTEADY

Wisconsin Univ., Milwaukee, Dept. of Mech., and Northwestern Univ., Evanston, Ill., Dept. of Civil

For primary bibliographic entry see Field 02F.

For abstract, see . W69-00123

HYDROLOGIC PROPERTIES OF SEVERAL UPLAND FOREST HUMUS TYPES IN THE LAKE STATES REGION, Michigan State Univ., East Lansing, Department of

Forestry. Wade L. Nutter, and Donald P. White. Proj completion Rep, June, 1968. 147 p. 27 fig, 7 tab, 42 ref, 4 append.

Descriptors: \*Humus, \*Hydrologic properties, \*Permeability, \*Specific retention, \*Evaporation, \*Moisture tension, Organic soils, Porosity, Forest soils, Moisture content, Soil water movement. Identifiers: Mulches.

Relatively undisturbed humus samples 16.5 cm in diameter and 25.4 cm deep were taken from 10 sites in forested Michigan regions and studied in the laboratory to determine the hydrological effect of humus on evaporation, infiltration, and water distribution, and to learn of the hydrology of humus formation. Humus types sampled are mull, duff-mull, mor, and a pseudo-duff mull. The mulls and duff-mulls held more water after drainage from saturation than the mors. The mors lost 80% by evaporation compared with 60% for the mulls and duff-mulls at high potential evaporation. Water moves rapidly through dry organic soils, wetting them only slightly. The suggestion that humus holds

water for later infiltration does not seem to be valid, but if humus horizons become saturated during storms of long duration, they can hold water against overland flow because of their high porosity. Humus types cannot be classified by hydrologic properties alone, but their hydrologic properties parallel the present classification system and support the validity of the distinct types described in the Great Lakes Region. (Knapp-USGS) W69-00128

EFFECT OF STRAW MULCH RATES ON SOIL WATER STORAGE DURING SUMMER FALLOW IN THE GREAT PLAINS,

For primary bibliographic entry see Field 03F. For abstract, see . W69-00144

WATER MOVEMENT IN DRY SOILS I. PHYSI-CAL FACTORS AFFECTING SORPTION OF WATER BY DRY SOIL,

Rothamsted Experimental Station, Harpenden, Herts., England.

J of Soil Sci, Vol 19, No 1, pp 81-93, March 1968. 13 p, 9 fig, 4 tab.

Descriptors: \*Soil water movement, Soil moisture, Arid lands, Atmosphere, Diffusivity, \*Tempera-ture, Salinity, Evaporation control, Environmental effects, \*Sorption, Water vapor, Water transfer, Equations, Soil aggregates, \*Moisture content, \*Soil physics.

The paper considered effects of various soil physical conditions on uptake of water from a moist atmosphere by a soil sufficiently dry that both liquid and vapor components of flow may be important. Water extraction by growing plants will dry soil in the root zone to c pF 4.2 and natural evaporation can dry surface layers to c pF 6 or even drier in arid regions. Theoretical aspects of water movement in dry soils were explained using 5 equations. Sorption took place in soil columns that were in a turbulent atmosphere at constant temperature and realtive humidity. Diffusivity rose to a maximum and then fell as water content increased. Effects of environment and management were studied in the areas of temperature, pressure, porosity, organic manure, aggregate size, still atmosphere, mulching, evaporation suppressents, ignition and degradation of structure. In the dry soils tested, water movement was a mixture of liquid and vapor transfer and the relative importance of the two modes of flow varied from soil to soil. The data showed the effect of pre-treatment on diffusity and sorptivity but there was no experience yet to indicate what changes might have agricultural sig-nificance. (Blecker-Ariz) W69-00148

CLIMATES OF SOME GREAT SOIL GROUPS OF THE WESTERN UNITED STATES.

California Univ., Berkeley.

Rodney J. Arkley. Soil Sci, Vol 103, No 6, pp 389-400, June 1967. 12 p, 5 fig.

Descriptors: \*Climatic zones, Arid climates, Weathering, \*Soil types, Soil moisture, Soil formation, Soil temperature, Air temperature, Leaching, Plant growth, Evapotranspiration, Organic matter, Precipitation excess, Rainfall, \*Reclamation states, \*Water balance, Storage capacity.

This paper summarizes an investigation of the distribution of soils in the 11 western states in relation to climatic parameters taken from the waterbalance analysis of 1082 climatic stations. The water-balance approach to climatic classification developed by Thornthwaite was used to relate climate directly to soil-forming processes. The method permitted an evaluation of the approximate moisture regime of soils throughout the year as well as the amount of water available for leaching and for plant growth. The leaching effec-

tiveness of the climate, the actual evapotranspiration, and the mean annual temperature considered simultaneously served to represent climatic factors most closely related to the kind of 'zonal' soils one would expect to find under each climate. The results indicate that soils in arid climates were effected by evapotranspiration, accumulation and decomposition of organic matter, central 'core' climate, air and soil temperature, rainfall, leaching, excess of precipitation and soil moisture-storage capacity. (Blecker-Ariz)
W69-00149

THE WATER BUDGET OF IRRIGATED PASTURE LAND NEAR MURRAY BRIDGE, SOUTH AUSTRALIA,

Australia Dept. of Agriculture, Adelaide. J. W. Holmes, and C. L. Watson. Agr Meteorol, Vol 4, No 3, pp 177-188, May 1967. 12 p, 2 fig, 1 tab, 1 append.

Descriptors: Irrigation practices, Pastures, \*Irrigation efficiency, Arid climates, Rainfall, Seepage, \*Evaporation, Surface drainage, \*Lysimeters, Radiation, \*Hydrologic budget, Climatic data, \*Equations \*Equations.

The measurement of water efficiency on an irrigation district basis was often inaccurate because of inadequate control of factors that occur in arid climates. The purpose of the experiment was to measure components of the water balance which included rainfall, amount of irrigation, evaporation, surface and underground drainage. Techniques of measurement yielded a standard error of about 10% of the total water inventory. The evaporation, measured with the help of small lysimeters, was strongly correlated with measured net radiation. Three formulae for estimating evaporation, based on large weighable lysimeters, were tried. By suitable choice of the coefficient for introducing the effect of the drying power of the air into the formula, it was possible to obtain a close estimate of evaporation. The correlation was no better than the correlation between evaporation and net radiation. (Blecker-Ariz) W69-00150

INFILTRATION IN SANDS AND ITS RELA-TION TO GROUNDWATER RECHARGE, U. S. Geological Survey, Washington, D. C.

W. O. Smith. Water Resources Res, Vol 3, No 2, pp 539-555, 1967. 17 p, 8 fig.

Descriptors: \*Infiltration, Capillary conductivity, Hydraulic conductivity, Soil moisture, \*Sands, \*Groundwater recharge, Arid climates, Topography, Field capacity, \*Sediments, Equations, Retention, Rocks.

Sediments consisting of boulders, gravel, sand and silt are, in addition to fissured rocks, the principle rocks capable of infiltration adequate for substantial groundwater recharge in arid climates. The problem considered in the study was infiltration into sands as related to groundwater recharge. The principles of capillarity applicable to infiltration process were reviewed. Qualitative experiments were described to show the nature of the hydraulic transfer process in sands. The problem of how deeply a given rain will penetrate into a sand, and under what conditions it will contribute to the recharge of groundwater, are considered. Influence of topography on groundwater recharge and the nature of specific retention or field capacity in sands were discussed. The infiltration process in dry sand consisted essentially of the downward passage of bulk water. Infiltration in sands was a simple hydraulic process subject only to modification by capillarity arising from the internal pore structure of the sand. The amount of water extracted from the infiltrating mass by a dry sand was determined by the specific retention of the sand. (Blecker-Ariz) W69-00160

#### Field 02-WATER CYCLE

#### Group 2G-Water in Soils

IN SITU MEASUREMENT OF SOIL SALINITY

WITH A SENSOR, U. S. Salinity Lab., Riverside, Calif. J. D. Oster, and R. D. Ingvalson. Soil Science Soc Proc, Vol 31, No 4, pp 572-574, July-August 1967. 3 p, 2 fig, 1 tab.

Descriptors: \*Saline soils, \*Electrical conductance, \*Temperature, Plant physiology, Soil profiles, Soil water movement, Irrigation effects, Moisture up-\*Measurement, Soil-water-plant relationships, Electrodes.

Identifiers: \*Thermistors, \*Sensors

Electrical conductivity (EC) of the soil solution was measured in situ with a salinity sensor whose salt-sensitive element was a ceramic electrical conductivity cell. The face electrode was covered with a thin layer of ceramic, thereby preventing dislodgment of the electrode and improving the stability of the sensor. The temperature correction used values from tables corresponding to the temperature as measured by the thermistor. The sensors measured changes in EC during an irrigation cycle due to water uptake by the plant and salt movement in the soil profile by convection of salt in the soil water. The accuracy of the measurement was estimated at plus or minus 0.5 mmho/cm. (Blecker-Ariz) W69-00163

THE QUALITY OF WATERS PERCOLATING THROUGH STRATIFIED SUBSTRATA, AS PREDICTED BY COMPUTER ANALYSES, California Univ., Water Resources Center, Davis. K. K. Tanji, L. D. Doneen, and J. L. Paul. Hilgardia, Vol 38, No 9, pp 319-347, June 1967. 29 p. 17 fb. 5th 6 append

p, 17 fig, 5 tab, 6 append

Descriptors: \*Water quality, \*Computer programs, \*Soil profiles, \*Soil chemical properties, Arid climates, Saturated soils, Percolating water, Gypsum, Cation exchange, Stratfied flow, Equations, \*Saturation, \*Analytical technique and techni ration, Analytical techniques, Stratification,

This paper presented theoretical consideration and procedures utilized in Fortran computer programs and resulting predictions on quality of waters percolating through three substrata profiles in the arid San Joaquin Valley of California. A study was done on prediction of chemical changes induced by saturating a stratfied substrata profile, prediction of quality of the percolating water and changes in chemical properties of the profile. Comprehensive predictions on solute concentrations in the percolate and chemical changes in the substrata profile were presented. Formulations in the computer programs were based on theoretical considerations concerning solubility and dissociation of gypsum and cation exchange. (Blecker-Ariz)

COMPUTER SYSTEM FOR THE REDUCTION AND ANALYSIS OF SOIL MOISTURE DATA, Virginia Polytechnic Institute, Blacksburg. For primary bibliographic entry see Field 07C.

For abstract, see

W69-00232

CALCULATED PERMEABILITY FROM

PERMEABILITY
DESATURATION DATA,
Canada Dep. of Agr., Lethbridge, Alberta, and
Oregon State Univ., Corvallis, and Colo. State Univ., Fort Collins.

Garland E. Laliberte, Royal H. Brooks, and Arthur

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5843, pp 57-71, Mar 1968. 15 p, 3 fig, 3 tab, 23 ref, 2 append.

Descriptors: \*Permeability, \*Porous media, \*Soils, \*Pore pressure, Drainage, Model studies, Equations, Soil compaction, Saturation, Regression analysis.

Identifiers: Capillary pressure-permeability relationships, Porosity-permeability relationships, Kozeny equations.

An equation is presented for calculating saturated permeability from capillary pressure-desaturation data. The use of this equation along with the relative permeability equations of Brooks and Corey is proposed for calculating the permeability of both saturated and partially saturated media. The analysis leading to the development of the equation is based on theory developed in the petroleum indus-try. The equation utilizes parameters introduced by Brooks and Corey for describing the hydraulic behavior of partially saturated porous media on the drainage cycle. In laboratory measurements, the permeability of three disturbed soils each packed at 5 different values of porosity was determined at various capillary pressures. Predicted relationships were calculated using capillary pressure-desaturation data in the new equation and in the relative permeability equations of Brooks and Corey. Calculated and experimental values of permeability agreed within 27% over the range of capillary pressures studied. (Knapp-USGS) W69-00236

CONTROLS ON Mn, Fe, Co, Ni, Cu, AND Zn CONCENTRATIONS IN SOILS AND WATER: THE SIGNIFICANT ROLE OF HYDROUS Mn AND Fe OXIDES,

U. S. Geological Survey, Denver, Colorado. For primary bibliographic entry see Field 02K. For abstract, see . W69-00259

A SOIL MOISTURE REGIME AND MICROCLI-MATOLOGICAL STUDY OVER SAND DUNES IN WESTERN RAJASTHAN,

Central Arid Zone Research Inst., Jodhpur, Rajasthan, India.

A. Krishnan, P. N. Bhatt, and P. Rakhecha. Ann of Arid Zone, Vol 5, No 1, pp 1-9, March 1966. 9 p, 4 fig, 3 tab.

Descriptors: \*Sands, Dunes, \*Soil moisture, Cli-Descriptors: Sanus, Johnes, Son Indistrict Communic data, Ecology, Soil temperature, Air temperature, Humidity, \*Microclimatology, Monsoons, Arid lands, Vegetation establishment. Identifiers: \*India.

In order to study the microclimate and soil moisture regime of the dunes of Rajasthan, stabilized and unstabilized dunes at Osian were selected. Diurnal cycle, microclimate and soil moisture observations were taken on two days during the four seasons: winter, hot weather period, monsoon and post monsoon. High moisture concentration occurred below 4 meter depth in the stabilized sand dune during March to July and below 1.5 meter depth in the unstabilized sand dune throughout the year. Vertical moisture movement under the influence of temperature gradients appeared to be the factor causing this occurrence. (Affleck-Ariz) W69-00365

INFLUENCE OF SOIL TEXTURE AND RAINFALL ON THE RESPONSE OF COTTON TO MOISTURE REGIME,

Lower Rio Grande Valley Research and Extension Center, U. S. Dept. of Agriculture, Weslaco, Texas. For primary bibliographic entry see Field 03F. For abstract, see . W69-00374

WATER ENTRY, WATER USE AND SEASONAL-MOISTURE REGIMES IN FLOOD-IRRIGATED RIVERINA SOILS, Australia CSIRO, Div. of Soils.

For primary bibliographic entry see Field 03F. For abstract, see . W69-00382

#### 2H. Lakes

ON THE INFLUENCE OF THE POLDERING OF LAKE TOGO-IKE FOR THE TOGO HOT

SPRING GROUP,
Japanese Society of Limnology, Otsu, Japan.
Kinzo Seno, Soki Yamamoto, and Shirobe Kiuchi.

Jap J of Limnol, Vol 29, No 1, pp 1-12, May 1968. 12 p, 7 fig, 6 tab.

Descriptors: \*Surface-groundwater relationships, \*Hot springs, \*Water temperature, \*Discharge (Water), Water-level fluctuations, Chlorides, Sulfate, Tidal effects, Water quality. Identifiers: Poldering, Lake Togo-ike, Japan.

The influence of change in lake level on the discharge of hot springs at Lake Togo-ike, a brackish lake situated in the middle of Tottori Prefecture, was studied. All of the springs of the Togo hot spring group have the same chemical con-stituents and ground temperature, suggesting that they have a common origin. Some of these springs discharge through the lake bottom, but they have little influence on quality of the lake water. Factors which will affect spring discharge are barometric pressure, rainfall lake-level change, tides, and pumping. Barometric and tidal effects are not separated. The effect of lake-level changes on the spring discharge, which is larger at Azusa than at Togo, suggests that change of lake level directly affects the discharge of hot springs. It is concluded that deepening of this lake will cause a decrease of hot springs discharge. (Knapp-USGS) W69-00132

LIMNOLOGICAL STUDIES OF A RESERVOIR, LAKE YUBARA-KO, OKAYAMA PREFEC-TURE.

Japanese Society of Limnology, Otsu, Japan. Masami Higuti.

Jap J of Limnol, Vol 29, No 1, pp 13-20, May 1968. 8 p, 3 fig, 1 tab, 2 ref.

Descriptors: \*Limnology, \*Eutrophication, \*Reservoirs, \*Plankton, \*Water quality, Dissolved oxygen, Hydrogen ion concentration, Amonia, Color, Turbidity, Opacity, Zooplankton. Identifiers: Yubara-Ko Lake, Japan.

The limnological features of Yubara-ko, a manmade lake in the northern part of Okayama Prefecture, which stores water for hydroelectric power, were investigated on August 7-10, 1965, 10 yr after were investigated on August 7-10, 1965, 10 yr after the water was impounded. The metalimnion developed between 15-16m and 23m. The color of water is Forel's Nos. 6-9, the Secchi's disc transparency varies from 1.5 to 4.0m. The pH-values range from 7.2 to 7.4 in the surface and from 6.0 to 7.3 in the bottom water. The contents of dissolved oxygen vary between 7.88-10.56 ppm in the surface and 8.67-10.4 ppm in the bottom water. Total Fe is 0.004-0.48 ppm in the bottom water. The Fe is 0.004-0.48 ppm in the bottom water. The amount of ammonium is 0.08 ppm, four times as much as that in 1958. Nutrients in the water have become richer in the past 10 yr. Of 30 species of plankton found, 11 are phytoplankton and 19 zooplankton. The plankton concentration ranged from 5,370 per 10 liters to 121 per 10 liters. (K-napp-USGS) W69-00134

FORECASTING THE LEVELS OF THE GREAT LAKES.

U. S. Lake Survey, Detroit, Michigan. B. G. Decooke, and E. Megerian. Water Resources Research, Vol 3, No 2, pp 397-403, Second Quarter 1967. 7 p, 4 tab, 5 ref, 1 ap-

Descriptors: \*Forecasting, \*Great Lakes, Water levels, Temperature, Precipitation, Time series analysis.

Identifiers: \*Net Basin Supply, Multiple linear regressions, Current trend.

A description is given of the U.S. Lake Survey method of forecasting Great Lakes water levels The method, in general, consists of determining a level for each month of a 6-month forecast period on each of the Great Lakes by routing a predicted volume of water (Net Basin Supply) to each of the Great Lakes basins. The technique employed in prediction of the volume of the water consists of veries multiple lines represent hard water 1. using multiple linear regressions based upon U. S.

Weather Bureau precipitation and temperature data as predictors for the first month and trend predictors for the second through the sixth month. This technique results in forecasting of lake levels on the average from 15 to 40% closer to the recorded lake levels, in comparison with the technique that utilizes the long-term average volume of water as the basis of projection. (Seneca-Rutgers) W69-00202

THE HIDDEN FLORA OF A LAKE,

Hebrew University of Jerusalem. For primary bibliographic entry see Field 05C. For abstract, see . W69-00360

THE LIMNOLOGICAL BEHAVIOR OF IRON IN

NATURAL WATER, Illinois State Water Survey, Peoria, Water Quality

For primary bibliographic entry see Field 05C. For abstract, see . W69-00388

#### 2I. Water in Plants

EFFECTS OF MOISTURE STRESS ON GER-MINATION OF ALKALI SACATON, GALLETA AND BLUE GRAMA, U. S. Forest Serv., Rocky Mountain Forest and Range Experiment Station, Albuquerque.

O. D. Knipe.
J Range Manage, Vol 21, No 1, pp 3-4, January 1968. 2 p, 1 fig, 2 tab.

Descriptors: \*Grasses, \*Moisture tension, \*Seeds, Germination, \*Moisture stress, Aqueous solutions.

The objective of the study was to determine the effect of moisture stress and seed germination. Seeds were collected within the arid Rio Puerco watershed near the village of San Luis, 58 miles northwest of Albuquerque, New Mexico. Each species was replicated four times at moisture tension levels of 0, 1, 4, 7, 10, 13, and 16 atm. Alkali sacaton was affected most by increases in moisture tension. Percent germination of alkali sacaton was significantly reduced by 1 atm moisture tension, and was further reduced by each 3 atm increase with the exception of 13 to 16 atm. Present germination of galleta and blue grama was not significantly reduced until a moisture tension of 10 atm was reached. The rapidity of germination of galleta and blue grama was delayed by moisture tension of 4 atm and the rapidity of germination of alkali sacaton was delayed by a moisture tension of 1 atm. (Blecker-Ariz) W69-00151

WATER USE IN LARGE SCALE IRRIGATION SCHEMES.

Irrigation Research Lab., Griffith, New South Wales, Australia.

For primary bibliographic entry see Field 03F. For abstract, see.

W69-00155

EFFECT OF TEMPERATURE ON NET ASSIMILATION RATE,

GSIRO, Canberra, Australia, Division of Plant In-

J. Warren Wilson. Ann of Botany, N S, Vol 30, No 120, pp 753-761, 1966. 11 p, 2 fig, 1 tab, 23 ref.

Descriptors: \*Temperature, Leaves, Arid climates, Sorghum, \*Growth rates, Plant physiology, Regres-

sion analysis, \*Plant growth.
Identifiers: \*Assimilation rate, Dry matter, Rape,

The net assimilation rates (rate of increase of dry matter per unit leaf area) and other growth at-

tributes were compared for rape, sunflower and maize plants growing at temperatures of 10, 16, 22, 28 and 34 deg C. These plants were grown in arid climates. Plants were widely spaced to reduce the mutual shading effect and grown under 3,000 f c fluorescent lighting to simulate summer weather. The estimates of the net assimilation rate (EA) suggested that the optimum temperature was lowest in rape (just over 20 deg C) and highest in maize (just below 30 deg C). Relative growth-rate (RW) was almost identical with relative leaf-area growth-rate (RA) at each temperature for rape and sunflower and both RW and RA rose more steeply than EA with increasing temperature. In hot climates EA fell with an increase in temperature in those species which had low optima. In warm conditions the EA rate varied little with temperature by only plus or minus 10% between 12 and 30 deg C for rape and 3 and 36 deg C for maize. (Blecker-Ariz) W69-00158

THE COMPOSITION OF SEVERAL ARID SPINIFEX GRASSLANDS OF CENTRAL AUS-TRALIA IN RELATION TO RAINFALL, SOIL

WATER RELATIONS, AND NUTRIENTS, Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research.

R. E. Winkworth.

Australia J of Botany, Vol 15, No 1, pp 107-130, 1967. 24 p,3 fig, 3 plate, 13 tab, 18 ref.

Descriptors: \*Grasslands, Arid climates, Biological communities, Climatic data, Soil-water-plant relationships, \*Rainfall, \*Temperature, Humidity, Evaporation, Geomorphology, Soil physical properties, Soil chemical properties, Plant physiology, \*Soil profiles, \*Vegetation regrowth, Environmental effects.

The paper reports the community analysis and associated climatic and soil studies of arid spinifex grasslands in five locations in the Northern Territory. All sand-plains were flat to broadly undulating. A study of the arid climate included rainfall, temperature, relative humidity and tank evaporation. Soils were studied with respect to morphology, physical and chemical properties and plant nutrition. The outstanding feature of the soils was their sandy nature, the profiles having large proportions of sand and low clay contents down to the underlying substrates. The vegetation study included a general description of where the plants were found, their floristic differences and quantitative community characteristics. Uniformity of the sand-plain vegetation of central Australia overrode minor geographical differences. The main climatic feature was the increase in rainfall from 5 in. annually to 14 in. from south to north. Communities regenerating from fire were very extensive (about 4000 sq. miles). The almost exclusive occupancy of the sand-plains by spinifex suggested true adaption to this soil environment. (Blecker-Ariz) W69-00162

COMPETITION BETWEEN BURROWEED AND ANNUAL AND PERENNIAL GRASSES FOR SOIL MOISTURE,

U. S. Forest Serv., Rocky Mountain Forest and Range Experiment Station, Tucson.

Dwight R. Cable. Proc Amer Forage and Grassland Counc, pp 11-27, 1966. 17 p, 8 fig.

Descriptors: \*Grasses, Plant groupings, Semiarid climates, Vegetation, Root development, Root distribution, \*Root systems, Environmental effects, Summer, \*Competition, Ecology, \*Soil moisture, Annual, Growth states, \*Plant growth, Phenology, Water requirements. Identifiers: \*Perennial, \*Burroweed.

A study was conducted to determine the extent of competition for soil moisture between annual grass, perennial grass and burroweed and the influence of rooting habits and growth cycles on these competitive relations. The study was conducted on the

Santa Rita Experimental Range, south of Tucson, Arizona, in a semidesert grass-shrub type area. The areas studied were herbage production, plant root systems, phenological development and moisture extraction patterns under different types of vegetation cover. Perennial grass production was reduced about 20% on plots with annual grass or burroweed competition and about 44% on plots with both. Because burroweed has a taproot system with little lateral spread and is primarily a spring grower, summer yields of annual and perennial grasses are only moderately affected by the presence of burroweed. Perennial grass, because of its deeper and perennial rooting habit, competed strongly with annual grasses during the summer growing season. (Blecker-Ariz) W69-00167

WATER STRESS IN NATIVE VEGETATION DURING THE DROUGHT OF 1965,

Australia Commonwealth Sci. Indus. Research

Org., Canberra. E. W. Pook, A. B. Costin, and C. W. E. Moore. Aust J Bot, Vol 14, No 2, pp 257-267, July 1966. 11 p, 4 tab, 3 plate.

Descriptors: \*Moisture stress, Vegetation, \*Droughts, Fine-textured soils, Trees, Soil \*Droughts, Fine-textured soils, Trees, Soil moisture, \*Moisture content, \*Biological communities, Rainfall, Soil profiles, Crop response, Wilting, \*Soil-water-plant relationships, Leaves.

Reported in this paper is the reaction of native vegetation in parts of the Australian Capital Territory and Monaro Region where drought occurred in 1965. The general pattern was for wilting to occur in lightertextured, stonier, or shallower soils, especially on steep and sunny aspects. Variation between the species of Eucalyptus was largely a reflection of site differences. Trees of all size classes showed signs of water stress. Relative moisture content of the foliage of E rossii on E macrorhyncha could be low before signs of water stress were obvious. Comparison of moisture contents of whole trees showing different degrees of water stress indicated that the prolonged period of dehydration had caused general drying out of the trees, rather than only leaf and twig desiccation.
The differences in soil moisture storage were chiefly a function of soil volume, as determined by profile depth and proportion of fine soil particles. It was suggested that the so-called ineffective summer rain in south-eastern Australia was both effective and essential for native communities on soils of low water-holding capacity. The role of drought in distribution of native communities was discussed. (Blecker-Ariz) W69-00168

ARIDITY AND SEMI-ARIDITY, A PHYTO-CLI-MATIC CONSIDERATION WITH REFERENCE TO INDIA,

Institut Français, Pondichery, India. For primary bibliographic entry see Field 06G. For abstract, see . W69-00369

GERMINATION STUDIES OF PENNISETUM GERMINATION STUDIES OF PENNISETUM TYPHOIDES SEEDS TREATED WITH SUC-CINIC ACID UNDER DIFFERENT WATER POTENTIALS, Central Arid Zone Research Inst., Jodhpur,

Rajasthan, India.

Man Singh Manohar, and M. K. Mathur. Ann of Arid Zone, Vol 4, No 2, pp 147-151, Sept 1965. 5 p, 1 fig, 2 tab.

Descriptors: \*Germination, Seeds, Arid lands, \*Growth rates, Osmosis, Plant growth.
Identifiers: \*Water potential, Succinic acid.

The influence of low water potentials on germina-tion of Pennisetum typhoides when treated with succinic acid was studied in India. Seeds were treated with four levels of succinic acid for 0, 3 and 6 hours. These seeds were then sown in 0, -500, -

#### Field 02-WATER CYCLE

#### Group 21—Water in Plants

1000 and -1500 joules/kg potential solutions. It was found varied levels of succinic acid had little effect upon total germination; however a marked effect was observed with varying osmosis potentials. Rate of germination as well as total germination were reduced in lower osmosis potentials. (Affleck-Ariz) W69-00370

#### 2.I. Erosion and Sedimentation

SEDIMENTARY AND FAUNAL FACIES AS-SOCIATED WITH THE DRAINING OF CROP-STON RESERVOIR

Nottingham Univ., Department of Geology, Great Britain.

W. A. Cummins, and A. J. Rundle.

The Mercian Geologist, Vol 2, No 4, pp 389-400, Aug 1968. 10 p, 2 fig, 1 tab, 2 plate, 3 ref.

Descriptors: \*Reservoirs, \*Drainage effects, \*Erosion, \*Biological communities, \*Sedimentation, Aquatic environment.

Identifiers: \*Reservoir drainage, \*Leicester, Great Britain, Faunal assemblages

The sedimentary and faunal changes resulting from the draining of Cropston Reservoir in Charnwood Forest, which supplied water to Leicester, England, were studied. The reservoir had been in continuous use for 95 years. The slow uniform deposition of black mud was interrupted and a new pattern of erosion, sedimentation and desiccation destroyed the molluscan fauna. Shoreline reed flora continued to flourish. Bottom muds were eroded and redeposited nearer the dam. Remains of the molluscan fauna were sampled and listed. The features produced by draining the reservoir are studied in terms of their preservation in the geological record when the reservoir is refilled and black mud sedimentation is resumed. Observation of a geological process taking place should help in the interpretation of the past geological record. (Knapp-USGS) W69-00090

#### URBANIZATION'S EFFECT ON SEDIMENT YIELD IN NEW JERSEY,

U S Geological Survey Peter W. Anderson, and John E. McCall. J Soil and Water Conserv, Vol 23, No 4, pp 142-144, July-Aug 1968. 3 p, 5 fig, 2 ref.

Descriptors: \*Sediment yield, \*Urbanization, Streams, Runoff, Storm runoff, New Jersey, Delaware River, Water pollution. Identifiers: Philadelphia, Trenton, New York City.

Data on sediment content of New Jersey streams are summarized; they suggest that yields are proportional to the degree of urbanization. The sparsely populated Pine Barrens yield 10-40 tons per sq mi per yr. The moderately heavily urbanized Delaware River area yields 25-100 tons generally, and up to 500 tons near Philadelphia. The northwestern area of New Jersey is hilly with steep slopes and rapid runoff, but a low degree of urbanization; its sediment yields are 25-100 tons per sq mi per yr, while yields in the Trenton-New York City area, which is very heavily urbanized and probably has about the same topography and natural sediment yield as the northwestern area, are several thousand tons. Bacteria and organic content of water are also much higher in urban streams. In the Delaware River near Trenton, 5-25% of the suspended load is oxidizable. The U S Geological Survey is studying the effects of urbanization on sediment in the Stony Brook Basin, about 48 sq mi in area, 10 mi north of Trenton. The amount of sediment for a given rate of runoff has increased significantly with urbanization of the area from 1956 to 1958. (Knapp-USGS)

# SEDIMENTATION IN THE NATION'S RESER-

Department of Agriculture, Oxford, Mississippi, Sedimentation Laboratory Farris E. Dendy.

J Soil and Water Conserv, Vol 23, No 4, pp 135-137, July-Aug 1968. 3 p, 5 fig, 1 tab, 15 ref.

Descriptors: \*Reservoir silting, Sediment yield, Reservoir storage, Trap efficiency.
Identifiers: Reservoir storage depletion.

Reservoir sedimentation data compiled by the U S Department of Agriculture Sedimentation Laboratory are summarized. The Nation's 968 reservoirs range from small ponds to over 1 million acre-ft. Annual average storage loss was 150,000 acre-ft, about 0.2% of initial total capacity, well within the design requirments of most reservoirs. Average depletion rates are much higher in reservoirs of 100 acre-ft or less, which account for only a small part of total reservoir capacity, but are 40% of the total number of reservoirs. Depletion was less than 1% for 58% of the reservoirs larger than 100,000 acreft, over 3% for 15% of the reservoirs, and in excess of 10% for only 2% of the reservoirs. Average sediment accumulation rates, in general, decrease as drainage area increases. Prediction of depletion rates can be successful only if local empirically determined relationships are used. The conclusions reached are that the depletion rate of 0.2% is not alarming, the 3% rate in small upland and reservoirs seems excessive, and if present rates continue, about 20% of small reservoirs will be half filled with silt in 30 years. (Knapp-USGS) W69-00119

#### DILUTION METHODS OF MEASURING TRANSPORT OF SAND FROM A POINT SOURCE.

Research Station, Hydraulics Wallingford. Berkshire, England.

G. H. Lean, and M. J. Crickmore.
J of Geophys Res, Vol 71, No 24, pp 5843-5855, December 1966. 13 p, 12 fig, 4 tab.

Descriptors: Transportation, \*Sands, Channels, Measurement, Particle size, \*Velocity, Elevation, Dye releases, \*Tracers, Flow, Dispersion, \*Diffusion, \*Equations, Steady flow, Sediment transport, Mixing, Streams.
Identifiers: \*Point source, \*Transport.

The object of the investigation was to compare lateral dispersion of sand and water in the absence of a lateral velocity gradient and to examine the validity of the point source tracer method for measurement of sand transport. Distribution of labeled particles from a steady point source and mean velocity and vertical diffusion coefficient were discussed using equations. The experiments demonstrated that in steady flow constant-dilution and time integration methods could be applied to measurement of sand transport by injection at a point source, provided that sediment transport was uniform across the width of the channel and a sufficient distance (20 feet in the case studied) was allowed between the point and measuring section for mixing. Independence of tracer concentration in elevation allows the method to be applied to samples taken in the suspended flow. Tracer concentrations measured both on the bed and in the water resulted in transport values accurate to within 5% for positions beyond the mixing distance. The methods described could be used to study transport of sand in streams and rivers in arid areas. (Blecker-Ariz) W69-00145

#### PROCESSES ON ARID-REGION ALLUVIAL FANS.

Minnesota Univ., Dept. of Geology and Geophysics Roger LeB Hooke

J of Geology, Vol 75, No 4, pp 438-460, July 1967. 23 p, 10 fig, 5 tab, 23 ref, 1 append.

Descriptors: \*Alluvial channels, \*Channel morphology, Slopes, Petrography, Infiltration, Weathering, \*Arid lands, Sediment discharge, Sediment transport, Alluvium, Geomorphology, Deposition (Sediments), Model studies, Mudflows, Sands Identifiers: \*Fans.

The object of the study was to understand processes acting on fans and features produced by these processes. Three fans were studied in the desert region of California. Reconnaissance work included qualitative observations of features such as debris size, lithology, channel form, fan area and slope. The laboratory study included fan morphology, qualitative relationships among fan slope, water discharge, debris-flow behavior and depth of fanhead incision. The fans had six distinguishable ages of alluvium and segmented profiles which may have resulted from tectonic disturbance of the fansource system. Small alluvial fans were built of mud and sand in a laboratory apparatus. These fans were not intended to be scale models of a natural fan but were treated as small fans in their own right. Justification for use of laboratory models was given. General equivalence of slopes on laboratory and natural fans indicated that gross scaling relationships between debris size and discharge were similar. Areas of debris flows, fluvial processes, mechanics of sediment transport, fan morphology, water flows, infiltration and sieve deposition, channels and deposition on alluvial fans and fanhead incision were discussed. (Blecker-Ariz) W69-00165

#### A MONOGRAPH ON SEDIMENT TRANSPORT IN ALLUVIAL STREAMS,

Denmark Technical Univ., Copenhagen. Frank Engelund, and Eggert Hansen Monogr, Denmark Tech Univ, Hydraul Lab, 62 p, 1967. 30 fig, 3 tab, 31 ref.

Descriptors: \*Sediment transport, \*Alluvial channels, \*Streams, \*Channel flow, \*Stage-discharge relations, Water conveyance, Hydraulics. Identifiers: Channel design, Monograph.

Transport of sediments in alluvial streams is explained in a generally non-mathematical or 'engineering' sense, and the basic mechanism of sediment transport is reviewed in a short text taken from lectures given at the University of Denmark. Part of the book is based on research in the Hydraulic Laboratory in Copenhagen and has not previously been presented except in discussions or progress reports. The topics covered are sediment properties, hydraulics of alluvial streams, the similarity principle, fluviology, and numerical examples of prediction of stage-discharge relations and design of channels. (Knapp-USGS) W69-00238

#### 2K. Chemical Processes

GEOCHEMISTRY OF GROUNDWATER FROM CRETACEOUS-LOWER UPPER SAND AQUIFERS IN SOUTH-WESTERN VIC-TORIA, AUSTRALIA,

Geological Survey, Melbourne, Australia, Mines

Department.
M. W. Johns.
J Hydrol, Vol 6, No 4, pp 337-357, Aug 1968. 21 p, 4 fig, 2 tab, 22 ref.

Descriptors: \*Water chemistry, \*Groundwater, Groundwater basin, Saline water, Sodium, Chlorides, Ion exchange, Magnesium, Sulfates, Carbonates.

Identifiers: \*Geochemical processes, Otway Basin, Victoria, Australia.

The groundwater chemistry of the sand aquifers in the upper Cretaceous and Lower Teriary of the Otway Basin, SW Victoria, Australia was studied by considering separately the main geochemical processes that produce variations in water composition. The processes are cation exchanges involved in formation of sodium bicarbonate, release of carbonic acid with variations in alkalinity, incorporation of originally oceanic saline water, and variations of sulfate-chloride ratio by sulfate accumulation or bacterial action. The waters have been mulation or bacterial action. The waters have been divided into several classes. Class A has Na:Cl less than 80, class B has Na:Cl between 80 and 95, class C has Na:Cl over 95 and Mg:Cl over 20, and class D has Na:Cl over 95 and Mg:Cl less than 20. Class B. C., and D waters are found elsewhere in Australia, but class A water is found only in the Otway Basin. (Knapp-USGS)

INTERACTION BETWEEN ALUMINUM AND PHOSPHATE IN AQUEOUS SOLUTION,

Rutgers Univ., New Brunswick, New Jersey

Advances in Chem Ser, No 73, pp 115-127, 1968. 13 p, 3 fig, 2 tab, 17 ref.

Descriptors: \*Phosphate, \*Aluminum, \*Inorganic compounds, \*Water chemistry. Identifiers: Complex ions, Polymers.

Hydroxy-aluminum solutions with NaOH/A1 molar ratios from 0 to 2.7 were mixed with a sodium phosphate solution to give a phosphate/Al ratio from 0 to 15, and it was found that hydroxy-aluminum polymers and Al ion did not yield the same reaction products with phosphate. The complete precipitation of hydroxy-aluminum polymers by phosphate at their isoelectric points was in-terpreted to be a simple 'neutralization' of the net positive charge of the polymer by the phosphate anion. Aluminum formed soluble complexes with phosphate up to a phosphate/A1 molar ratio of 8. In solution with polymers and Al ions, each reacted with phosphate separately because there is no rapid equilibrium between A1 ion and polymers.
(Knapp-USGS)
W69-00257

CONTROLS ON Mn, Fe, Co, Ni, Cu, AND Zn CONCENTRATIONS IN SOILS AND WATER: THE SIGNIFICANT ROLE OF HYDROUS Mn AND Fe OXIDES,

U. S. Geological Survey, Denver, Colorado.

E. A. Jenne.

Advances in Chem Ser, No 73, pp 337-387, 1968. 51 p, 6 fig, 1 tab, 257 ref.

Descriptors: \*Trace elements, \*Soil chemical properties, \*Oxides, \*Water chemistry, \*Sorption, Chelation, Organic matter, Carbonates, Clays. Identifiers: Hydrous oxides, Complex ions.

It is proposed that the hydrous oxides of Mn and Fe, in general, furnish the principal control on the fixation of Co, Ni, Cu, and Zn (heavy metals) in soils and fresh water sediments; hydrous oxides of Mn and Fe are nearly ubiquitous in clays, soils, and sediments. The common occurrence of these oxides as coating, allows the oxides to exert chemical activity far out of proportion to their total concentrations. Sorption or desorption of these heavy metals occurs in response to the following factors: (1) aqueous concentration of the metal in question; (2) aqueous concentration of other heavy metals; (3) pH; and (4) amount and strength of organic chelates and inorganic complex ion formers present in solution. Other suggested controls on the concentration of the heavy metals in soils and fresh waters are: (1) organic matter; (2) clays; (3) carbonates; and (4) precipitation as the discrete oxide or hydroxide. The available information on these controls is reviewed and found to be inadequate to explain the fixation of Co, Ni, Cu, and Zn. (Author) W69-00259

EFFECT OF RECLAMATION SYSTEM AND CULTIVATION ON THE DISTRIBUTION OF SALINITY AND ALKALINITY IN SOIL PROFILES IN AN AREA IN NORTHERN PART OF THE NILE DELTA, Cairo Univ., Cairo, Egypt, Soils Dept.

For primary bibliographic entry see Field 03F. For abstract, see . W69-00376

THE RELATION OF HUMIC COLOR TO IRON

IN NATURAL WATERS, Minnesota Univ., Minneapolis, Limnological Research Center.

For primary bibliographic entry see Field 05B. For abstract, see . W69-00385

#### 2L. Estuaries

SALT-WATER ENCROACHMENT IN THE SOUTH EDISTO RIVER ESTUARY, SOUTH CAROLINA,

U. S. Geological Survey, Water Resources Division, Washington, D. C.

T. Ray Cummings

U S Geol Surv Water-Supply Pap 1586-I, 1968. 19 p, 12 fig, 2 tab, 11 ref.

Descriptors: \*Encroachment, \*Estuaries, \*South Carolina, Tidal effects, Discharge (Water), Saline water intrusion, Water quality, Winds, Dissolved solids

Identifiers: \*South Edisto River, \*Specific conductance.

A study of salt-water encroachment in the South Edisto River, South Carolina, found that chemical characteristics are altered to about 25 mi upstream from the mouth. Precise correlations of discharge, tide, and weather, the factors affecting distance of the salt-water encroachment, with specific chemical characteristics are not possible in the report area. Mean discharge, flow duration, high tide frequency, relation of specific conductance to discharge, frequency curves of specific conductance, relation of dissolved solids to conductance, frequency curves for dissolved solids and chlorides, and water temperatures, are presented graphically. Tables show maximum and minimum values of dissolved solids and the physical proper-ties of water at 2 gaging stations. (Knapp-USGS) W69-00104

DELAWARE COAST, BEACH EROSION CONTROL AND HURRICANE PROTECTION. Army Corps of Engineers, Washington, D. C.

U S 90th Congr, 2d Sess, Senate Doc No 90, 110 p, 1968. 21 photo, 20 tab, 1 append, 1 suppl.

Descriptors: \*Beach erosion, \*Shore protection, \*Flood control, \*Landfills, \*Coastal engineering, Hurricane, Delaware.

Identifiers: Delaware, Atlantic coastal area

A beach erosion and hurricane protection study of beaches along the Delaware Coast found that all the public and private beaches have been damaged by erosion, and that improvements landward of the beaches are threatened. The quantity of sand supplied naturally to the beaches by littoral drift is insufficient to offset the loss from storms and high tides. Plans of improvement for individual localities, financed as small beach erosion control projects, consisting of initial placement of fill, periodic nourishment of beaches, construction of groins where required, and maintenance and replacement of existing structures, are economically justified only for Broadkill Beach, South Bowers, and Lewes. Beach erosion control for the entire Delaware Coast financed as a whole, consisting of fill, bulkheads, nourishment, placement of sand fences, and planting of dune grass is, however, economically justified by the benefits in prospect. The estimated first cost is \$8,044,000, annual cost is \$157,700, and the benefit-cost ratio is 1.4 for the northern reach and 1.6 for the southern reach. (Knapp-USGS) W69-00114

MIXING OF THE CONGO RIVER WATERS WITH THE WATERS OF THE SOUTH ATLAN-

Institut geographique du Congo.

Jean Meulenbergh.

Academie Royale des Sciences d'Outre-Mer, Classe des Sciences Techniques, NS, 16-6, Brus-sels, 1968. 148 p, 55 fig, 4 tab, 28 ref. Trans by

Descriptors: \*Estuarine environment, \*Watersheds (Basins), \*Aquatic environment, Fish migration, Tidal effects, Water temperature, Fish attractants. Identifiers: \*Water mixing, \*Congo River, Africa, Oceanography.

As a contribution to knowledge of the fluviomarine zone of the Congo River, an analysis is presented based on hydrological data collected by electronic sounding and other equipment between 1959 and 1963. The fluviomarine water quality varies with changing river discharge (between 25,000-60,000 cu m/sec) and the nature of the marine water. Effects of tides, coastal currents, and wind action are discussed. Temperature and salinity observations are graphed. Contrary to general belief, the study shows that in this zone there is turbulent mixing of fresh and sea waters of different salinity and temperature. At about 20 m depth, river waters mix with cold salt waters of the submarine canyon. T-S diagrams indicate that at certain seasons, normal salinity occurs at depths between 20-25 m. The data are considered of interest to maritime fishing, because fish leave the too-warm waters of the Gulf of Guinea (24-30 deg C) that are low in salinity (33-34 parts per thousand), and lack plankton and other nutrients. Diffusion and mixing are reduced vertically by a thermocline at 30 m which is a zone preferred by fish. Bathythermograms indicate the zone does not mix with the Guinea water mass. (Llaverias-USGS) W69-00138

BREVARD COUNTY, FLORIDA (BEACH ERO-SION CONTROL).

Army Corps of Engineers, Washington, D. C.

U S 90th Congr, 2d Sess, House Doc No 352, 74 p, 1968. 10 fig, 1 plate, 13 tab, 1 suppl, 1 append.

Descriptors: \*Beach erosion, \*Shore protection, \*Coastal engineering, Dredging, Harbors, Jetties, Littoral drift, Florida.

County, Florida, Cape Brevard Identifiers: Canaveral, Cape Kennedy.

Investigation of beach erosion south of Canaveral Harbor, Florida, shows that the jetties and other harbor works are intercepting the southward littoral drift of sand and as a consequence erosion of the beaches of Brevard County is severe. Remedial measures proposed include development and protection of 2.8 miles of beach immediately south of Canaveral Harbor and at Indialantic and Melbourne Beach. Nourishment of the beach at the City of Cape Canaveral would be provided by a sand transfer plant which would restore the littoral drift now being intercepted by the harbor works. First costs are estimated to be \$852,000 for the city of Cape Canaveral and \$511,000 for Indialantic-Melborne Beach; estimated annual costs are \$34,700 and \$81,800 respectively. The plan is economically justified with benefitcost ratios of 5.9 for Cape Canaveral and 2.5 for Indialantic and Melbourne Beach. It is recommended that the Federal Installations at Cape Kennedy and Patrick Air Force Base also undertake remedial measures to be paid for by the Federal agencies involved. (K-napp-USGS) W69-00242

RIVER CHANNEL BARS AND DUNES--THEORY OF KINEMATIC WAVES, RIVER

U. S. Geological Survey.
Walter B. Langbein, and Luna B. Leopold.
U S Geol Surv Prof Pap 422-L, pp L1-L20, 1968. 19 fig, 4 tab, 20 ref.

#### Field 02-WATER CYCLE

#### **Group 2L—Estuaries**

Descriptors: \*Sediment transport, \*Sediment distribution, \*Dunes, \*Sand bars, Meanders, Model studies, Flumes.

Identifiers: \*Kinematic waves.

A study of the movement of beads carried in moving water in a narrow flume, and of sand in a pipe or flume in dune movement shows that flux-concentration curves characteristic of kinematic wave movement can be constructed. From the kinematic point of view, concentration of particles in dunes and other wave bed forms results when particles in transport become sufficiently numerous or closely spaced to interact and reduce the effectiveness of the ambient water to move them. Field observations over a 5-yr period are reported in which individual rocks were painted for identification and placed at various spacings on the bed of an ephemeral stream in New Mexico, to study the effect of storm flows on rock movement. The data on about 14,000 rocks so observed show the effect of variable spacing which is quantitatively as well as qualitatively comparable to the spacing effect on small glass beads in a flume. Dunes and gravel bars may be considered kinematic waves caused by particle interaction, and certain of their properties can be related to the characteristics of the flux-concentration curve. (Knapp-USGS) W69-00260

NUTRIENT AND ENERGY CYCLES IN AN ESTUARINE OYSTER AREA,

Dalhousie Univ, Halifax, Nova Scotia, Inst. of Oceanography.

For primary bibliographic entry see Field 05C. For abstract, see W69-00386

#### 03. WATER SUPPLY **AUGMENTATION** AND CONSERVATION

#### 3B. Water Yield Improvement

THE PROBLEM OF THE PALEOKARSTIC DAMMAM LIMESTONE AQUIFER IN KU-WAIT.

Food and Agriculture Organization of the United Nations, Rome, and Dept. of Water and Gas, Government of Kuwait.

David J. Burdon, and Abdullah Al-Sharhan. J Hydrol, Vol 6, No 4, pp 385-404, Aug 1968. 20 p, 2 fig, 2 tab, 21 ref.

Descriptors: \*Aquifers, \*Karst, Limestones, Water yield, Water quality, Paleohydrology. Identifiers: Kuwait, Paleokarst, Limestone, Imported water.

A preliminary study of the Dammam Limestone shows that the karstic zones developed in Upper Eocene and Oligocene time should yield more water of better quality than zones of lower permeawater of better quality than zones of lower permea-bility. The Kuwait City and Ahmadi municipal well fields yield 27 million cubic meters of poor-quality water (4,000 ppm TDS). Further groundwater development is planned. It may be possible to use the anisotropic aquifer for storage of imported water. The piezometric surface of the aquifer was mapped, the general stratigraphy of Kuwait is shown in a table, and a cross section shows the Karstic nature and problems of development of the Dammam Limestone. (Knapp-USGS)

QUALITY OF SURFACE WATERS OF THE QUALITY OF SURFACE WATERS OF THE UNITED STATES 1960: PARTS 9-14, COLORADO RIVER BASIN TO PACIFIC SLOPE BASINS IN OREGON AND LOWER COLUMBIA RIVER BASIN.

U. S. Geological Survey.
For primary bibliographic entry see Field 02E. For abstract, see . W69-00126

GROUND-WATER RESOURCES OF AC-COMACK AND NORTHAMPTON COUNTIES, VIRGINIA.

U. S. Geological Survey.
Allen Sinnott, and G. Chase, Tibbitts, Jr. Virginia Dep of Conserv and Econ Develop, Div of Mineral Resources, Rep 9, 1968. 113 p, 7 fig, 4 plate, 8 tab, 25 ref.

Descriptors: \*Groundwater, \*Water resources, \*Water wells, \*Aquifers, \*Virginia, Coastal plains, Water yield, Water quality.
Identifiers: \*Accomack

Virginia, County, \*Northampton County, Virginia, Delmarva.

Groundwater resources of Accomack and Northampton counties, in the Virginia part of the Delmarva peninsula, were studied by the USGS and the Virginia Division of Mineral Resources. Mean annual temperature is 58 deg and the precipitation is 43 in. Thin surficial Pleistocene sands, and clays are underlain by Miocene deposits which supply most of the water for municipal and industrial uses. Chemical character of the deeper water suggests hydraulic connection with the artesian aquifers east of Chesapeake Bay. Domestic water is mainly from wells in the Pleistocene deposits. Larger wells are mainly in Miocene aquifers; one near Exmore yielded 746 gpm with 37 ft of drawdown, and one at Cape Charles yields 645 gpm. The water is good, moderately hard, and usually low in iron and fluoride. Deep Miocene wells yield water high in bicarbonate and fairly high in chloride. Withdrawal is not excessive anywhere and the supply is adequate for foreseeable needs. Well descriptions, aquifers, water levels, yields, and chemical analyses are tabulated. Maps, cross sections and a strati-graphic column show well location, geology, and stratigraphy. (Knapp-USGS) W69-00127

PRELIMINARY REPORT ON THE WATER RESOURCES OF THE KAHUKU AREA, OAHU, HAWAII.

U. S. Geological Survey, Honolulu, Hawaii For primary bibliographic entry see Field 02F. For abstract, see . W69-00130

PRELIMINARY REPORT ON THE WATER RESOURCES OF THE KAU DISTRICT, HAWAII.

U. S. Geological Survey, Honolulu, Hawaii For primary bibliographic entry see Field 02F. For abstract, see . W69-00131

RECORDS OF NORTH-SIDE SPRINGS AND OTHER INFLOW TO SNAKE RIVER BETWEEN MILNER AND KING HILL, IDAHO, 1948-67,

U. S. Geological Survey. For primary bibliographic entry see Field 02E. For abstract, see . W69-00137

WATER RESOURCES AND SURFICIAL GEOLOGY OF THE HOMER AREA, SOUTH-CENTRAL ALASKA, U S Geological Survey

For primary bibliographic entry see Field 02F. For abstract, see . W69-00140

CONTOUR FURROWING, PITTING, AND RIPPING ON RANGLANDS OF THE WESTERN UNITED STATES,

U. S. Geological Survey, Water Resources Div.,

F. A. Branson, R. F. Miller, and I. S. McQueen. J of Range Manage, Vol 19, No 4, pp 182-190, July 1966. 9 p, 12 fig, 25 ref.

Descriptors: \*Mechanical equipment, Contour furrows, Ranges, \*Grasslands, Crop response, Finetextured soils, Vegetation, Precipitation intensity, Runoff, Altitude, Soil moisture, Moisture content, Salinity, Furrows, Reclamation states, Sediment control, Soil water movement, Halophytes.

During the growing season of 1964, the effects of mechanical treatment on rangelands administered by the Bureau of Land Management were measured in Montana, Wyoming, Colorado, Utah, New Mexico and Arizona. Variables evaluated in the study included kinds of mechanical treatments, soils, vegetation types, variation in precipitation, altitude, latitude and longitude. No well-defined relationship was found between annual precipitation and altitudes with respect to treatments. The purposes of mechanical land treatments were to reduce runoff, thereby increasing moisture storage for plant use, and to decrease sediment and water movement from treated sites. Salinity and pH did not appear related to treatment success. Mediumto medium-fine textured soils were the most suitable for mechanical treatment. The halophytic Nuttall saltbush responded more favorably to contour furrowing than did any other type sampled. Of the seven kinds of mechanical treatments, the contour furrowing and broadbase furrowing were the most effective. Treatment of winter fat resulted in a decrease in perennial grass production. (Blecker-W69-00147

EVALUATION OF FIVE APPLICATION METHODS FOR APPLYING EVAPORATION SUPPRESSANTS TO THE SURFACE OF SMALL WATER STORAGES,

Manitoba Univ., Agricultural Engineering Dept., Winnipeg. H. M. Lapp

Can Agr Eng, Vol 10, No 1, pp 17-22, May 1968. 6 p, 6 fig, 16 ref.

Descriptors: Emulsions, \*Evaporation control, Hexadecanol, Octadecanol, \*Monomolecular films, \*Reservoir evaporation, Precipitation, \*Application methods, Rates of application, Alcohols, Semiarid climates, Water storage, \*Retardants, Wind velocity.

In semi arid regions, potential evaporation losses frequently exceed annual precipitation values. Seven methods were listed that could be employed to reduce evaporation from water storages. A review of evaporation suppression and the physical properties of monolayer materials was given. The five application methods evaluated were: manual powder, continuous emulsion, continuous solution, intermittent powder and continuous powder. The superior evaporation suppressant to date appears to be a mixture of approximately equal quantities of hexadecanol and octadecanol. A methyl alcohol based solution of about 5% concentration and a dry fine powder are suitable forms of evaporation suppressant for application to a water surface. An evaporation suppressant should be generated continuously from the upwind shore and at rates proportional to wind speeds to form an efficient monolayer for evaporation suppression. A continuous application of dry fine powder from a dispenser located on the upwind shore was judged to be the most practical and efficient method of applying an evaporation suppressant to small water storages. (Blecker-Ariz) W69-00153

THE LAKE SUPERIOR WATERSHED UNIT. Minnesota State Department of Conservation For primary bibliographic entry see Field 06D. For abstract, see.

W69-00180

SIMULATION OF GREAT LAKES BASIN WATER SUPPLIES,

U. S. Lake Survey, Detroit and Inland Waters Branch, Ottawa, Canada. Edmond Megerian and Ralph L. Pentland. Water Resources Research, Vol 4, No 1, pp 11-17, February 1968. 7 p, 3 fig, 3 tab, 6 ref.

Use of Water of Impaired Quality-Group 3C

escriptors: \*Model studies, \*Water supply, Great Lakes, Mathematical models, Testing, Perstence

ientifiers: \*Net basin supply, Simulation studies, wo-station model, Multivariate model, Great akes Basin, Autocorrelation test.

he basic concept utilized in the simulation study is statistically evaluate the recorded supplies in rder to isolate the two components assumed to oner to isolate the two components assumed to onstitute the basin water supply: (1) that portion if the supply that is considered random, owing to nance interaction of unpredictable meteorological nance interaction of unpredictable meteorological lements, and (2) that portion of the supply that is the result of the persistance due to natural storage in the lakes, soil, bedrock, and snow over the rainage basin. In this study, consideration was also iven to the relationship between supplies in eighboring basins. These factors were used to forward the metals and the for simulation of sure pulate mathematical models for simulation of suplies to all of the Great Lakes simultaneously. Exensive statistical tests have been used to ensure nat the statistical parameters and the time series haracteristics of the simulated data resemble hose of the recorded data. (Seneca-Rutgers) V69-00201

# CLIMATE AND STREAMFLOW OF PUERTO

NICO, J. S. Geological Survey, San Juan, Puerto Rico, Water Resources Division.

E. V. Giusti, and M. A. Lopez. Caribbean J Sci, Vol 7, No 3-4, pp 87-93, Sept-Dec 1967. 7 p, 5 fig, 1 tab, 4 ref.

Descriptors: \*Rainfall-runoff relationships, \*Puero Rico, Streamflow, Climatology, Synoptic analy-

dentifiers: Thornthwaite's method, Climatic index.

The presently available data on streamflow, runoff rainfall, and temperature of Puerto Rico are evalu-ated, although the period of record is very short, with a view to contributing to the knowledge of hydrology of tropical islands. The average annual streamflow in Puerto Rico is 56% of the annual rainfall, or 15% more than in the Eastern Piedmont of the US where it is 30%. Climate is assumed to be responsible for this difference as well as for the difresponsible to this differences of the flows of Puerto Rican streams which vary from 15 to 85% of the annual rainfall. Variations in the climate of Puerto Rico are shown by Thornthwaite's climatic index on a map of the Island, and the variations of the streamflow to rainfall ratios of Puerto Rican streams are shown to be related to Thornthwaite's climatic index. (Knapp-

#### W69-00253

#### RECESSION CHARACTERISTICS OF IOWA STREAMS.

Iowa Univ., Iowa City.

J. W. Howe. Iowa State Water Resources Res Inst Bull 43, Iowa Univ, 32 p, 1968. 12 fig, 2 tab.

Descriptors: \*Recession curves, \*Streamflow forecasting, lowa, Low flow, Surface-groundwater relationships.

The behavior of lowa streams in low-water periods during the crop-growing season, May to Sept inclusive, was determined. The flow records in all such periods to 10 days or more in length were analyzed to determine recession constants. The results are shown on a map of the state and indicate a considerable uniformity of behavior during each of the summer months. The flow at the beginning of the periods was related to the area and soil permeabili-ty of the drainage basin and to the antecedent temperature and precipitation by means of correlation techniques. Data were obtained from the USGS, US Weather Bureau, and the US Soil Conservation Service. The lower parts of recession hydrographs with steady declines of at least 10 days were plotted using logarithmic discharge and linear time scales. The best straight line through the plotted points was constructed, breaks in slope were assumed to

mark the beginning of groundwater flow, and recession constants were calculated. The recession constants were plotted on maps showing station locations. Observed and predicted discharges were plotted for May through Sept. Values of the recession constants and a summary of stations, data, and results are tabulated. (Knapp-USGS)

#### WATER CONTROL DISTRICT RESOURCES.

Detroit Univ Law School. T. E. Lauer. U of Detroit L J, Vol 37, No 1, pp 28-75, Oct 1959. 47 p, 344 ref.

Descriptors: \*Water resources development, \*Administration, \*Water districts, Drainage districts, Levees, Flood control, Water policy, Administrative agencies, \*Great Lakes region, State governments, Water management (Applied), Water

Identifiers: Multiple-purpose districts, Single-purnose districts.

Water use law is not the only law directly affecting water resources— 'water development law' is a second major area which is directed at group or community protection, and is based on cooperation instead of conflict. This article is concerned with water districts, a branch of water development law, with detailed emphasis on the developments in the Great Lakes States. Single-purpose districts are often used because needs arise and are recognized singularly. Drainage districts are usually established to drain potential farmland, and their powers were severely limited. Flood control, levee, and river improvement districts are usually established to allow participation in federally financed programs. Water supply districts, pollution control and sewage disposal districts, and various miscellaneous single-purpose districts are considered in detail. The modern tendency is toward multiple-purpose districts, which provide various economies. Conservancy and watershed districts and soil conservation districts are discussed, detailing Great Lakes States provisions. Advantages such as local control, and disadvantages such as financing problems are discussed in regard to districts. Problems involved in creating districts (i.e. geographical boundaries and scope of powers) are considered W69-00267

#### APPROACHES TO WATER RESOURCE DEVELOPMENT IN CENTRAL AND SOUTHERN FLORIDA, 1845-1947, John M. DeGrove

Florida Univ., Gainesville, 1958. 53 p.

Descriptors: \*Federal government, \*State government, \*Land reclamation, Coordination, \*Florida, Water resource development, Crops, Multiple-purpose projects, Legislation, Drainage practices, Navigation, Project planning, Flood control, Op-timum development plans, Political aspects, Ad-ministration, Drainage districts, Soil properties,

This study consists of a selective survey of federal, state, local and private efforts to solve the water state, local and private efforts to solve the water control problem of central and southern Florida from 1845 to 1947. It is selective because the study does not purport to be a general history of the subject during this period. Within a broad historical framework, specific kinds of problems are selected for analysis. These problems are concentrated within the general problem areas of administration, economics, and policy. The aim will be to attempt to discover whether experience in the evolution of the Florida project is useful in better understanding the Florida project is useful in better understanding the general nature of the problems in the areas to be concentrated on. It is also hoped that by better understanding how present patterns in the administration, finance, and federal-state-local fields have evolved, it will be possible to face more realistically the task of making improvements in each of the areas treated.

W69-00268

# OPTIMUM OPERATION OF A MULTI-RESER-

VOIR WATER SUPPLY SYSTEM, Stanford University, Stanford, California. For primary bibliographic entry see Field 06A. For abstract, see . W69-00349

WATER QUALITY MANAGEMENT, Univ of Oklahoma, Norman.

For primary bibliographic entry see Field 06A. For abstract, see. W69-00355

#### 3C. Use of Water of Impaired **Quality**

#### DUHON V BUCKLEY (SALINE WATER INTRU-SION).

161 So 2d 301-307 (La 1964).

Descriptors: Louisiana, Judicial decisions, Salinity, \*Rice farms, Oil wells, \*Saline water-freshwater interfaces, Brine disposal, \*Desalination, \*Water pollution, Damages.

This was an action by four rice farmers against several owners of an oil well for damage to their rice fields, because the defendants had permitted salt water from their well to flow into the source from which plaintiffs pumped water for their rice fields. Defendants denied that their negligence caused any significant change in the salinity of the water source, and even if it had, that plaintiffs were contributorily negligent because they did not check for salt content before filling the rice fields. It was held that defendants' mine was the only possible source of salt water in the area, that the water in the rice fields and the water source was unusable for rice growing, and that plaintiffs did not have a duty to check for salinity before pumping water onto their fields. (Crabtree-Fla) W69-00012

# SOURCES OF SALINE WATER IN THE UPPER BRAZOS RIVER BASIN, TEXAS, U. S. Geological Survey. Jack Rawson, M. W. Flugrath, and Leon S. Hughes.

US Geol Surv Progr Rep to June 1967, Mar 1968. 163 p, 2 fig, 8 tab, 23 ref.

Descriptors: \*Saline water, \*Water pollution Descriptors.

\*Texas, Data collections, Water quality,
Discharge (Water), Water wells, Oil fields.
Identifiers: Brazos River Basin, Texas.

Sources of salt in Brazos River, west-central Texas, were studied to determine the best means of al-leviating saline-water problems in connection with developing the basin's water resources. The Brazos above Possum Kingdom Reservoir is too saline for most uses; in the reservoir the salinity is usually over 1,200 ppm. The upper Brazos contributes only 18% of the total river flow, but about 55% of TDS, 85% of the chloride, and 75% of the sulfate. Poor water quality is due principally to inflow of natural brine, solution of calcium sulfate from soil and rocks, and pollution by oil field brine. Salt yields, chemical quality records, chemical analyses of stream water, records of wells and streams, annual discharge summaries, annual water quality summaries, quality of Possum Kingdom Reservoir water, and hypothetical reservoir water quality based on partial control of natural salinity, are tabulated. The major salt-contributing areas are described in detail. One stream, Salt Croton Creek, contributes about 27% of the dissolved solids, 42% of the chloride, and less than 5% of the sulfate to Possum Kingdom Reservoir. (Knapp-USGS) W69-00136

#### Field 02-WATER CYCLE

#### **Group 2L—Estuaries**

Descriptors: \*Sediment transport, \*Sediment distribution, \*Dunes, \*Sand bars, Meanders, Model studies, Flumes.

Identifiers: \*Kinematic waves.

A study of the movement of beads carried in moving water in a narrow flume, and of sand in a pipe or flume in dune movement shows that flux-concentration curves characteristic of kinematic wave movement can be constructed. From the kinematic point of view, concentration of particles in dunes and other wave bed forms results when particles in transport become sufficiently numerous or closely spaced to interact and reduce the effectiveness of the ambient water to move them. Field observations over a 5-yr period are reported in which individual rocks were painted for identification and placed at various spacings on the bed of an ephemeral stream in New Mexico, to study the effect of storm flows on rock movement. The data on about 14,000 rocks so observed show the effect of variable spacing which is quantitatively as well as qualitatively comparable to the spacing effect on small glass beads in a flume. Dunes and gravel bars may be considered kinematic waves caused by particle interaction, and certain of their properties can be related to the characteristics of the flux-concentration curve. (Knapp-USGS) W69-00260

NUTRIENT AND ENERGY CYCLES IN AN ESTUARINE OYSTER AREA,

Dalhousie Univ, Halifax, Nova Scotia, Inst. of Oceanography.

For primary bibliographic entry see Field 05C. For abstract, see . W69-00386

# 03. WATER SUPPLY AUGMENTATION AND CONSERVATION

#### 3B. Water Yield Improvement

THE PROBLEM OF THE PALEOKARSTIC DAMMAM LIMESTONE AQUIFER IN KUWAIT.

Food and Agriculture Organization of the United Nations, Rome, and Dept. of Water and Gas, Government of Kuwait.

David J. Burdon, and Abdullah Al-Sharhan. J Hydrol, Vol 6, No 4, pp 385-404, Aug 1968. 20 p, 2 fig, 2 tab, 21 ref.

Descriptors: \*Aquifers, \*Karst, Limestones, Water yield, Water quality, Paleohydrology. Identifiers: Kuwait, Paleokarst, Dammam

Limestone, Imported water.

A preliminary study of the Dammam Limestone shows that the karstic zones developed in Upper Eocene and Oligocene time should yield more water of better quality than zones of lower permeability. The Kuwait City and Ahmadi municipal well fields yield 27 million cubic meters of poor-quality water (4,000 ppm TDS). Further groundwater development is planned. It may be possible to use the anisotropic aquifer for storage of imported water. The piezometric surface of the aquifer was mapped, the general stratigraphy of Kuwait is shown in a table, and a cross section shows the Karstic nature and problems of development of the Dammam Limestone. (Knapp-USGS) W69-00125

QUALITY OF SURFACE WATERS OF THE UNITED STATES 1960: PARTS 9-14, COLORADO RIVER BASIN TO PACIFIC SLOPE BASINS IN OREGON AND LOWER COLUMBIA RIVER BASIN.

U. S. Geological Survey. For primary bibliographic entry see Field 02E. For abstract, see . W69-00126 GROUND-WATER RESOURCES OF ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA.

U. S. Geological Survey.
Allen Sinnott, and G. Chase, Tibbitts, Jr.
Virginia Dep of Conserv and Econ Develop, Div of

Virginia Dep of Conserv and Econ Develop, Div of Mineral Resources, Rep 9, 1968. 113 p, 7 fig, 4 plate, 8 tab, 25 ref.

Descriptors: \*Groundwater, \*Water resources, \*Water wells, \*Aquifers, \*Virginia, Coastal plains, Water yield, Water quality. Identifiers: \*Accomack County, Virginia,

Identifiers: \*Accomack County, Virginia \*Northampton County, Virginia, Delmarva.

Groundwater resources of Accomack and Northampton counties, in the Virginia part of the Delmarva peninsula, were studied by the USGS and the Virginia Division of Mineral Resources. Mean annual temperature is 58 deg and the precipitation is 43 in. Thin surficial Pleistocene sands, and clays are underlain by Miocene deposits which supply most of the water for municipal and industrial uses. Chemical character of the deeper water suggests hydraulic connection with the artesian aquifers east of Chesapeake Bay. Domestic water is mainly from wells in the Pleistocene deposits. Larger wells are mainly in Miocene aquifers; one near Exmore yielded 746 gpm with 37 ft of drawdown, and one at Cape Charles yields 645 gpm. The water is good, moderately hard, and usually low in iron and fluoride. Deep Miocene wells yield water high in bicarbonate and fairly high in chloride. Withdrawal is not excessive anywhere and the supply is adequate for foreseeable needs. Well descriptions. aquifers, water levels, yields, and chemical analyses are tabulated. Maps, cross sections and a strati-graphic column show well location, geology, and stratigraphy. (Knapp-USGS) W69-00127

PRELIMINARY REPORT ON THE WATER RESOURCES OF THE KAHUKU AREA, OAHU, HAWAII.

U.S. Geological Survey, Honolulu, Hawaii. For primary bibliographic entry see Field 02F. For abstract, see. W69-00130

PRELIMINARY REPORT ON THE WATER RESOURCES OF THE KAU DISTRICT, HAWAII,

U.S. Geological Survey, Honolulu, Hawaii. For primary bibliographic entry see Field 02F. For abstract, see. W69-00131

RECORDS OF NORTH-SIDE SPRINGS AND OTHER INFLOW TO SNAKE RIVER BETWEEN MILNER AND KING HILL, IDAHO, 1948-67.

U. S. Geological Survey.
For primary bibliographic entry see Field 02E.
For abstract, see .
W69-00137

WATER RESOURCES AND SURFICIAL GEOLOGY OF THE HOMER AREA, SOUTH-CENTRAL ALASKA,

U S Geological Survey. For primary bibliographic entry see Field 02F. For abstract, see . W69-00140

CONTOUR FURROWING, PITTING, AND RIPPING ON RANGLANDS OF THE WESTERN UNITED STATES,

U. S. Geological Survey, Water Resources Div., Denver.

F. A. Branson, R. F. Miller, and I. S. McQueen. J of Range Manage, Vol 19, No 4, pp 182-190, July 1966. 9 p, 12 fig, 25 ref.

Descriptors: \*Mechanical equipment, Contour furrows, Ranges, \*Grasslands, Crop response, Fine-

textured soils, Vegetation, Precipitation intensity, Runoff, Altitude, Soil moisture, Moisture content, Salinity, Furrows, Reclamation states, Sediment control, Soil water movement, Halophytes. Desc 'Gre

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During the growing season of 1964, the effects of mechanical treatment on rangelands administered by the Bureau of Land Management were measured in Montana, Wyoming, Colorado, Utah, New Mexico and Arizona. Variables evaluated in the study included kinds of mechanical treatments, soils, vegetation types, variation in precipitation, altitude, latitude and longitude. No well-defined relationship was found between annual precipitation and altitudes with respect to treatments. The purposes of mechanical land treatments were to reduce runoff, thereby increasing moisture storage for plant use, and to decrease sediment and water movement from treated sites. Salinity and pH did not appear related to treatment success. Mediumto medium-fine textured soils were the most suita-ble for mechanical treatment. The halophytic Nuttall saltbush responded more favorably to contour furrowing than did any other type sampled. Of the seven kinds of mechanical treatments, the contour furrowing and broadbase furrowing were the most effective. Treatment of winter fat resulted in a decrease in perennial grass production. (Blecker-Ariz) W69-00147

AN EVALUATION OF FIVE APPLICATION METHODS FOR APPLYING EVAPORATION SUPPRESSANTS TO THE SURFACE OF SMALL WATER STORAGES,

Manitoba Univ., Agricultural Engineering Dept., Winnipeg.

H. M. Lapp. Can Agr Eng, Vol 10, No 1, pp 17-22, May 1968. 6 p, 6 fig, 16 ref.

Descriptors: Emulsions, \*Evaporation control, Hexadecanol, Octadecanol, \*Monomolecular films, \*Reservoir evaporation, Precipitation, \*Application methods, Rates of application, Alcohols, Semiarid climates, Water storage, \*Retardants, Wind velocity.

In semi arid regions, potential evaporation losses frequently exceed annual precipitation values. Seven methods were listed that could be employed to reduce evaporation from water storages. A review of evaporation suppression and the physical properties of monolayer materials was given. The five application methods evaluated were: manual powder, continuous emulsion, continuous solution, intermittent powder and continuous powder. The superior evaporation suppressant to date appears to be a mixture of approximately equal quantities of hexadecanol and octadecanol. A methyl alcohol based solution of about 5% concentration and a dry fine powder are suitable forms of evaporation suppressant for application to a water surface. An evaporation suppressant should be generated continuously from the upwind shore and at rates proportional to wind speeds to form an efficient monolayer for evaporation suppression. A continuous application of dry fine powder from a dispenser located on the upwind shore was judged to be the most practical and efficient method of applying an evaporation suppressant to small water storages. (Blecker-Ariz)

THE LAKE SUPERIOR WATERSHED UNIT.
Minnesota State Department of Conservation.
For primary bibliographic entry see Field 06D.
For abstract, see.
W69-00180

SIMULATION OF GREAT LAKES BASIN WATER SUPPLIES,

U. S. Lake Survey, Detroit and Inland Waters Branch, Ottawa, Canada.

Edmond Megerian and Ralph L. Pentland. Water Resources Research, Vol 4, No 1, pp 11-17, February 1968. 7 p, 3 fig, 3 tab, 6 ref.

Use of Water of Impaired Quality—Group 3C

Descriptors: \*Model studies, \*Water supply. \*Great Lakes, Mathematical models, Testing, Per-

Identifiers: \*Net basin supply, Simulation studies, Two-station model, Multivariate model, Great Lakes Basin, Autocorrelation test.

The basic concept utilized in the simulation study is to statistically evaluate the recorded supplies in order to isolate the two components assumed to constitute the basin water supply: (1) that portion of the supply that is considered random, owing to chance interaction of unpredictable meteorological elements, and (2) that portion of the supply that is the result of the persistance due to natural storage in the lakes, soil, bedrock, and snow over the in the lakes, soil, bedrock, and snow over the drainage basin. In this study, consideration was also given to the relationship between supplies in neighboring basins. These factors were used to formulate mathematical models for simulation of supplies to all of the Great Lakes simultaneously. Extensive statistical tests have been used to ensure that the statistical parameters and the time series characteristics of the simulated data resemble those of the recorded data. (Seneca-Rutgers) W69-00201

# CLIMATE AND STREAMFLOW OF PUERTO

RICO, U. S. Geological Survey, San Juan, Puerto Rico,

O. S. Geological Survey, San Juan, Puerto Rico, Water Resources Division. E. V. Giusti, and M. A. Lopez. Caribbean J Sci, Vol 7, No 3-4, pp 87-93, Sept-Dec 1967. 7 p, 5 fig, 1 tab, 4 ref.

Descriptors: \*Rainfall-runoff relationships, \*Puerto Rico, Streamflow, Climatology, Synoptic analy-

Identifiers: Thornthwaite's method, Climatic index.

The presently available data on streamflow, runoff rainfall, and temperature of Puerto Rico are evaluated, although the period of record is very short, with a view to contributing to the knowledge of hydrology of tropical islands. The average annual streamflow in Puerto Rico is 56% of the annual rainfall, or 15% more than in the Eastern Piedmont of the US where it is 30%. Climate is assumed to be responsible for this difference as well as for the differences of the flows of Puerto Rican streams which vary from 15 to 85% of the annual rainfall. Variations in the climate of Puerto Rico are shown by Thornthwaite's climatic index on a map of the Island, and the variations of the streamflow to rainfall ratios of Puerto Rican streams are shown to be related to Thornthwaite's climatic index. (Knapp-USGS) W69-00253

# RECESSION CHARACTERISTICS OF IOWA

STREAMS, Iowa Univ., Iowa City. J. W. Howe.

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Iowa State Water Resources Res Inst Bull 43, Iowa Univ, 32 p, 1968. 12 fig, 2 tab.

Descriptors: \*Recession curves, \*Streamflow forecasting, Iowa, Low flow, Surface-groundwater relationships.

The behavior of lowa streams in low-water periods during the crop-growing season, May to Sept inclusive, was determined. The flow records in all such periods to 10 days or more in length were analyzed to determine recession constants. The results are shown on a map of the state and indicate a considerable uniformity of behavior during each of the summer months. The flow at the beginning of the periods was related to the area and soil permeability of the drainage basin and to the antecedent temperature and precipitation by means of correlation techniques. Data were obtained from the USGS, US Weather Bureau, and the US Soil Conservation Service. The lower parts of recession hydrographs with steady declines of at least 10 days were plotted using logarithmic discharge and linear time scales.

The best straight line through the plotted points was constructed, breaks in slope were assumed to

mark the beginning of groundwater flow, and recession constants were calculated. The recession constants were plotted on maps showing station locations. Observed and predicted discharges were plotted for May through Sept. Values of the recession constants and a summary of stations, data, and results are tabulated. (Knapp-USGS) W69-00262

#### OF WATER CONTROL DISTRICT RESOURCES,

Detroit Univ Law School.

T. E. Lauer.

U of Detroit L J, Vol 37, No 1, pp 28-75, Oct 1959. 47 p, 344 ref.

Descriptors: \*Water resources development, \*Administration, \*Water districts, Drainage districts, Levees, Flood control, Water policy, Administrative agencies, \*Great Lakes region, State governments, Water management (Applied),

Identifiers: Multiple-purpose districts, Single-purpose districts.

Water use law is not the only law directly affecting water resources— 'water development law' is a second major area which is directed at group or community protection, and is based on cooperation instead of conflict. This article is concerned with water districts, a branch of water development law, with detailed emphasis on the developments in the Great Lakes States. Single-purpose districts are often used because needs arise and are recognized singularly. Drainage districts are usually established to drain potential farmland, and their powers were severely limited. Flood control, levee, and river improvement districts are usually established to allow participation in federally financed programs. Water supply districts, pollution control and sewage disposal districts, and various miscellaneous single-purpose districts are considered in detail. The modern tendency is toward multiple-purpose districts, which provide various economies. Conservancy and watershed districts and soil conservation districts are discussed, detailing Great Lakes States provisions. Advantages such as local control, and disadvantages such as financing problems are discussed in regard to districts. Problems involved in creating districts (i.e. geographical boundaries and scope of powers) are considered. W69-00267

# APPROACHES TO WATER RESOURCE DEVELOPMENT IN CENTRAL AND SOUTHERN FLORIDA, 1845-1947, John M. DeGrove.

Florida Univ., Gainesville, 1958. 53 p.

Descriptors: \*Federal government, \*State government, \*Land reclamation, Coordination, \*Florida, Water resource development, Crops, Multiple-purpose projects, Legislation, Drainage practices, Navigation, Project planning, Flood control, Op-timum development plans, Political aspects, Ad-ministration, Drainage districts, Soil properties,

This study consists of a selective survey of federal, state, local and private efforts to solve the water control problem of central and southern Florida from 1845 to 1947. It is selective because the study does not purport to be a general history of the sub-ject during this period. Within a broad historical framework, specific kinds of problems are selected for analysis. These problems are concentrated within the general problem areas of administration, economics, and policy. The aim will be to attempt to discover whether experience in the evolution of the Florida project is useful in better understanding the general nature of the problems in the areas to be concentrated on. It is also hoped that by better understanding how present patterns in the admini-tration, finance, and federal-state-local fields have evolved, it will be possible to face more realistically the task of making improvements in each of the areas treated.

W69-00268

#### OPTIMUM OPERATION OF A MULTI-RESER-VOIR WATER SUPPLY SYSTEM,

Stanford University, Stanford, California. For primary bibliographic entry see Field 06A. For abstract, see . W69-00349

#### WATER QUALITY MANAGEMENT,

Univ of Oklahoma, Norman. For primary bibliographic entry see Field 06A. For abstract, see W69-00355

#### 3C. Use of Water of Impaired **Ouality**

#### **DUHON V BUCKLEY (SALINE WATER INTRU-**SION).

161 So 2d 301-307 (La 1964).

Descriptors: Louisiana, Judicial decisions, Salinity, \*Rice farms. Oil wells. \*Saline water-freshwater interfaces, Brine disposal, \*Desalination, \*Water pollution, Damages.

This was an action by four rice farmers against several owners of an oil well for damage to their rice fields, because the defendants had permitted salt water from their well to flow into the source from which plaintiffs pumped water for their rice fields. Defendants denied that their negligence caused any significant change in the salinity of the water source, and even if it had, that plaintiffs were contributorily negligent because they did not check for salt content before filling the rice fields. It was held that defendants' mine was the only possible source of salt water in the area, that the water in the rice fields and the water source was unusable for rice growing, and that plaintiffs did not have a duty to check for salinity before pumping water onto their fields. (Crabtree-Fla) W69-00012

# SOURCES OF SALINE WATER IN THE UPPER BRAZOS RIVER BASIN, TEXAS,

U. S. Geological Survey. Jack Rawson, M. W. Flugrath, and Leon S. Hughes.

US Geol Surv Progr Rep to June 1967, Mar 1968. 163 p, 2 fig, 8 tab, 23 ref.

Descriptors: \*Saline water, \*Water pollution Sources, \*Texas, Data collections, Water quality, Discharge (Water), Water wells, Oil fields. Identifiers: Brazos River Basin, Texas.

Sources of salt in Brazos River, west-central Texas, were studied to determine the best means of alleviating saline-water problems in connection with developing the basin's water resources. The Brazos above Possum Kingdom Reservoir is too saline for most uses; in the reservoir the salinity is usually over 1,200 ppm. The upper Brazos contributes only 18% of the total river flow, but about 55% of TDS, 85% of the chloride, and 75% of the sulfate. Poor water quality is due principally to inflow of natural brine, solution of calcium sulfate from soil and rocks, and pollution by oil field brine. Salt yields, chemical quality records, chemical analyses of stream water, records of wells and streams, annual discharge summaries, annual water quality summaries, quality of Possum Kingdom Reservoir water, and hypothetical reservoir water quality based on partial control of natural salinity, are tabulated. The major salt-contributing areas are described in detail. One stream, Salt Croton Creek, contributes about 27% of the dissolved solids, 42% of the chloride, and less than 5% of the sulfate to Possum Kingdom Reservoir. (Knapp-USGS) W69-00136

#### Field 03—WATER SUPPLY AUGMENTATION AND CONSERVATION

#### Group 3F—Conservation in Agriculture

Descriptors: Federal Government, \*Irrigated land, \*Water policy, Central U. S., Subsurface waters, Water utilization, \*Supply, Bodies of water, Water utilization, \*Water demand.

Identifiers: Economics, \*Irrigation.

This paper examines the trends in irrigation. Even though there has been rapid expansion of irriga-tion, physical potentials for further development exist. The amount of irrigable lands in the Great Plains States is related to the cropland harvested. Studies suggest that there may be ten million acres available for irrigation for which there are reasonable prospects of supplying water. The development of this potential irrigable acreage should be done by public agencies. The public interest will not be satisfied solely by the development of irrigable acreage since demands from non-agricultural uses of water exists, and these demands will increase in the future. Therefore, the development of water resources for irrigation purposes will have to be judged in relation to other beneficial uses. (Grossman-Rutgers)

IRRIGATION IN THE FUTURE.

Leeds, Hill and Jewett, Inc., Cons Engrs, San Francisco. California

For primary bibliographic entry see Field 06B. For abstract, see W69-00195

# FRAMEWORK FOR ANALYSIS OF IRRIGA-

TION DEVELOPMENT,
Oklahoma State Univ., Stillwater, Department of Agricultural Economics For primary bibliographic entry see Field 06B. For abstract, see .

#### HYDROLOGIC ASPECTS OF NO-TILLAGE VERSUS CONVENTIONAL TILLAGE SYSTEMS FOR CORN PRODUCTION,

Virginia Polytechnic Institute, Blacksburg V.O. Shanholtz, and J. H. Lillard. OWRR report A-009-Va, Virginia Water Resource Research Center, Bull No 4 June 1968, 31 p, 6 figs, 8 tab. 45 ref.

Descriptors: Water conservation, Evapotranspiration, \*Soil-water-plant relationships, \*hydrologic budget, \*Mulching, Evaporation control, Runoff, Moisture availability, Droughts, \*Moisture content, Hydrologic models.

The hydrologic aspects of no-tillage and conventional tillage systems for corn production are com-pared. Differences in available soil moisture content are discussed with respect to water use efficiency, droughts, and yields. A mathematical model for simulating plant available soil moisture is presented. (Shanholtz-Va Tech) W69-00231

# MANAGEMENT: A KEY TO IRRIGATION EF-

Dep of Agriculture, Phoenix, Arizona, Agricultural Research Service

Leonard J. Erie

W69-00196

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR3, Pap 6107, pp 285-293, Sept 1968. 9 p, 4 tab, 2 fig, 10 ref.

Descriptors: \*Water management (Applied), \*Irrigation practices, \*Water consumption (Plants), \*Water loss, Evapotranspiration, Water utilization, Soil-water-plant relationship, Conservation. Identifiers: \*Irrigation efficiency, Crop irrigation.

Water consumption and efficiency of crop irriga-tion are discussed with relation to management. Water losses that occur in transporting from sources to ultimate irrigation sites are described, and some unavoidable water losses in management procedure are identified. Comparisons are made between various water uses, particularly those in

industry and agriculture, and consumptive use data are discussed relative to conservation. Because irrigated agriculture accounts for 80%, or more, of all water consumed in the U S, the greatest opportunity for water conservation exists in good irrigation management. About 60% of the water withdrawn for irrigation is lost through evapotranspiration, and another large percentage is not otherwise beneficially used by plants. Inefficient applica-tion occurs because of lack of knowledge about soils, root systems, and consumptive use estimates by the manager. (Lang-USGS) W69-00233

#### STABLE ALKANOL DISPERSION TO REDUCE EVAPORATION,

Dept. of Agriculture, Phoenix, Arizona, Water Conservation Lab.

Gary W. Frazier, and Lloyd E. Myers.

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5849, pp 79-89, Mar 1968. 11 p, 3 fig, 2

Descriptors: \*Evaporation control, \*Alcohols, \*Monomolecular films, \*Surfactants, \*Dispersion, Suspension, Solvents, Hexadecanol, Octadecanol. Identifiers: Alkanols.

Highly stable sol- or gel-type dispersions of longchain alkanols in water have been prepared and shown to be more effective than powdered alkanol in reducing evaporation from water surfaces. Surfactants used to prepare the dispersions are algi-cides and bactericides. Dispersion samples have shown no separation or deterioration after 5 yr storage under nonsterile condit ons. Concentrated dispersions can be prepared for shipment or storage and can be diluted with water containing up to 1,700 ppm soluble salts to make stable, lowviscosity dispersions for application with simple drip-type applicators. Film release rates and film pressures from dispersions exceed those from powder. Fifty pounds of powdered alkanol per acre per month r duced evaporation from outdoor tanks by 15% under adverse testing conditions. Under the same conditions only 10 lb of dispersed alkanol per acre per month reduced evaporation by 28%. (Author) W69-00249

#### CONSUMPTIVE USE DERIVED FROM EVAPORATION PAN DATA, USAID, Bogota, Columbia.

George H. Hargreaves.

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5863, pp 97-105, Mar 1968. 9 p, 5 tab, 10

Descriptors: \*Evapotranspiration, \*Evaporation. \*Consumptive use, \*Climatic data, Irrigation programs, Rainfall, Evaporation pans.

Identifiers: Irrigation requirements, Evapotranspiration calculations.

Evapotranspiration measurements or computations provide basic information for the computation of irrigation requirements. Unfortunately, in underdeveloped or developing countries both evapotranspiration and weather data are usually of limited availability and for some proposed project areas nonexistent. Formulas and methods are required by engineers working on design and development of irrigation. These must permit the evaluation of needs and requirements for irrigation with an absolute minimum of data. Formulas are given for computing evaporation from climate data. Ratios of evapotranspiration to Class A pan evaporation are given for a large number of crops. Crops are grouped together or assigned general classifications whenever possible. Consumptive use coefficients converting evaporation to evapotrans-piration are given by 10% increments of the crop growing season or vegetative cycle. A method of computing utilizable rainfall is presented and a formula is given for converting evapotranspiration to irrigation requirements. Irrigation requirements may be computed with several levels of data availability if temperature and rainfall measurements at the disposal of the engineer constitute the minimum of data required. (Author) W69-00252

#### WATER RIGHTS IN LOUISIANA.

Louisiana Law Review, Baton Rouge. Jerry G. Jones.

La L Rev, Vol 16, No 3, pp 500-511, Apr 1956. 12 p, 49 ref.

Descriptors: Louisiana, Civil law, Water law, Water rights, Administrative agencies, State jurisdiction, Irrigation, Legislation.

Article 661 of the Civil Code, a typical expression of riparian doctrine, allows water usage only to those whose land abuts a stream. This basic legislation has been supplanted in areas where irrigation is controlled by administrative agencies. The enactment of R S 9:1101 declaring all waters to be the property of the State of Louisiana with the privilege of use by everyone further complicates the picture. If 661 is construed as unaffected by this legislation, an application of the general rules of servitude still yield many inequitable results, e g prohibition against riparian owner's use of water to serve nonriparian lands ajoining his riparian estate, but which have been purchased subsequent to the initial exercise of the servitude. Comprehensive legislation is needed to eliminate present doubt and conflict. W69-00266

#### PROBLEMS OF FEDERALISM IN RECLAMA-TION LAW.

Colorado Univ. Law Review, Boulder. Joseph L. Sax

U Colo L Rev, Vol 37, No 1, pp 49-84, Fall 1964. 36 p. 157 ref.

Descriptors: \*Federal Reclamation Law, \*Federalstate water rights conflicts, Recreation, United States, State jurisdiction, \*Compensation, Water reuse, States, Water policy, Reclamation, Irrigation, \*Water allocation (Policy), Competing uses, Judicial decisions. Identifiers: Federal Farm Policy, Surplus Crops.

The problems raised here center on Section 8 of Reclamation Act of 1902. This section delineates the rights reserved to the states where a Federal reclamation program is in force. Section 8 was originally interpreted to place state law above federal law whenever a conflict occurred. Recent cases indicate by dicta that the section now should be read so as to give state law priority only in situations concerning compensation for the loss of private property rights. Brief attention is paid to various legislation such as the Boulder Canyon Project Act, the Warren Act, the Reclamation Extension Act, and the Fryingpan-Arkansas Project law. Extensive analysis of the legislative history of the Reclamation Act is provided. The role of the Dept. of Interior in the area of recreation in water areas is discussed, with a conclusion that it will play a quite active role both in policy planning and administration. The relationship between the Reclamation Acts and Federal Farm policy is discussed with the conclusion being that Congress intended to utilize the reclamation laws to promote farm policy. W69-00294

THE IRRIGATION DEMAND PHASE OF THE WATER SUPPLY AND DEMAND PROJECT (SECTION I: IMPROVING THE DESIGN OF ECONOMIC IRRIGATION SYSTEM - CROP RESPONSE),

Cornell University, Ithaca, N. Y., Agricultural En-

Gilbert S. Levine, J. Kampen, and I. Seginer.

OWRR Project No. A-001-NY, Technical Report
No. 14, Cornell Water Resources and Marine Sciences Center, September 1968. 21 p, 6 fig, 7

# WATER QUANTITY MANAGEMENT AND CONTROL—Field 04

#### Control of Water on the Surface—Group 4A

Descriptors: Irrigation design, \*Soil-water-plant relationships, \*Evapotranspiration, \*Crop response, Potatoes, Forage mixtures, Vegetable rons.

The yield responses of 8 vegetable crops, potatoes, and a variety of forages to additions of water were determined from past research in 5 Northeastern U.S. states. A relatively simple analysis and interpretation scheme revealed some generalizations: (1) for most vegetables there is a positive correla-tion between yield and water added; (2) the rate of yield response decreases when the water added is excessive, and may become negative; (3) this break point is approximately 13 in. for short season crops, 20 in. for potaotes and 20 to 22 in. for forages. Yield response of forages is between 0 and 500 lbs per inch of water used. (Levine-Cornell) per inch or w W69-00311

THE USE OF WATER BY COTTON CROPS IN ABYAN, SOUTH ARABIA,

Empire Cotton Growing Corp., Namulonge, Ugan-

D. A. Rijks. J. Applied Ecol, Vol 2, No 2, pp 317-343, Nov 1965. 27 p, 13 fig, 5 tab, 28 ref.

Descriptors: \*Evaporation, \*Cotton, Irrigation practices, \*Rates of application, Water balance, Soil moisture, \*Moisture content, \*Energy budget, Temperature, Humidity, Crop production, Soil physical properties, Soil profiles, Meteorological data, Water utilization.

Identifiers: South Arabia, \*Energy balance.

The object of a study conducted in South Arabia was to estimate by two methods, the actual evaporation from cotton crops grown under four different rates of irrigation. Evaporation was estimated from water balance studies, which took into account rainfall, irrigation and changes in soil water content. A second estimate was obtained by combing measurements of the energy balance over cotton with the temperature and humidity profiles in and above the crop. The four rates of irrigation, applied before sowing were 15, 45, 60 and 90 cm of water which resulted in the crops using 14, 34, 46 and 67 cm of water respectively. A relation between the decrease in yield and time of onset of water strain was presented. It was concluded that the most efficient use of water resulted when irrigation rates were adjusted to provide 50 cm of available water. (Affleck-Ariz) W69-00367

INFLUENCE OF SOIL TEXTURE AND RAIN-FALL ON THE RESPONSE OF COTTON TO MOISTURE REGIME,

Lower Rio Grande Valley Research and Extension Center, U. S. Dept. of Agriculture, Weslaco, Texas. C. J. Gerard, and L. N. Namken. Agron J, Vol 58, pp 39-42, Jan-Feb 1966. 4 p, 5 fig, 3 tab.

Descriptors: \*Soil texture, Rainfall, Crop response, \*Cotton, Root distribution, \*Soil moisture, Texas, Rates of application, Irrigation water, Arid lands, \*Soil physical properties, Fine-textured soils, \*Crop production

Identifiers: Medium-textures soils, \*Moisture

A paper was presented which discussed the influence of soil texture and related rooting characteristics and of rainfall on the response of cotton to different soil moisture regimes in the Lower Rio Grande Valley of Texas. Cotton on medium textured soils developed an extensive root which was able to extract water to depths of 4 to 5 feet, while on fine-textured soils cotton was only able to extract water to 2 feet. On medium-textured soils cottract water to 2 feet. On incumination selection needed only 1 or 2 irrigations to produce satisfactory yields. It was found that cotton on fine-textured soils needed to be irrigated every 10 to 15 days starting at the first bloom. This study will provide important information for arid regions in that

the best time to use a limited supply or irrigation water can be determined. (Affleck-Ariz)

OPTIMAL TIMING OF IRRIGATION,

California Univ., Riverside, Dept. of Engineering. Warren A. Hall, and William S. Butcher. Nevada Univ., Reno, Dept. of Engineering Affiliate Inst. J Irrig and Drainage Div (ASCE), Vol 94, No IR 2, Proc Paper 5993, pp 267-275, June 1968. 8 p.

Descriptors: \*Irrigation efficiency, \*Timing, \*Dynamic programming, \*Optimization, Yield equations, \*Mathematical models, Water supply, Irrigation water, Analytical technique, Rates of application, Growth stages, Cost-benefit analysis, Water distribution, Supplemental irrigation.

A methodology was derived permitting determination by dynamic programming of the optimal timing of irrigation, to produce the greatest net return inclusive of the cost of irrigation. It was particularly useful under conditions in which seasonal supply was inadequate but reasonably predictable. The analysis was based on the principle that the adverse effects of deficiencies (nutrition, excessive salinity and soil moisture) were geometric when existing in combination. For general use, additional data concerning the yield coefficients will be required covering each of the critical stages in the growth of the crops independently. (Affleck-Ariz) W69-00375

EFFECT OF RECLAMATION SYSTEM AND CULTIVATION ON THE DISTRIBUTION OF SALINITY AND ALKALINITY IN SOIL PROFILES IN AN AREA IN NORTHERN PART OF THE NILE DELTA,

Cairo Univ., Cairo, Egypt, Soils Dept. Abdella Zein el Abedene, Amin Abdel Barr, and A.

M. el Akyabi. J Soil Sci (UAR), Vol 5, No 2, pp 89-109, 1965. 21 p, 7 tab, 5 fig.

Descriptors: \*Land reclamation, \*Cultivation, \*Salinity, \*Alkalinity, \*Soil profiles, Soil chemical properties, Groundwater, Salts, Sampling, Chemical analysis, Ions, Sodium, Adsorption, Solubility.
Identifiers: United Arab Republic, \*Cations,

The effect of reclamation and cultivation upon chemical properties of the soil was studied in the northern Nile Delta. Ten profiles from five localities in a cultivated area and also an adjacent barren area were studied. By comparison, it was shown that salt content in the cultivated soil crust decreased from 8.19 to 0.58 m/mhos. An accumulation of salt was found at approximately 20 cm below the soil surface in cultivated soil unlike the gradual decrease of uncultivated soils. The ground water salinity of cultivated soils was 1.3 to 31.5% of the salinity of barren soils. It was also shown the cultivated soil was more alkaline due to removal of salt giving higher values for pH, exchangeable sodium percentage, soluble sodium percentage and Na/Ca+Mg ratios. (Affleck-Ariz) W69-00376

SOIL MOISTURE RESPONSE TO SPRAYING BIG SAGEBRUSH WITH 2,4-D,

Rocky Mountain Forest and Range Experiment Station, Laramie, Wyoming.

Ronald D. Tabler. J Range Management, Vol 21, No 1, pp 12-15, January 1968. 4 p, 4 fig.

Descriptors: \*Soil moisture, \*Spraying, Vegetation regrowth, \*Evapotranspiration control, Nuclear moisture meters, Soil profiles, \*Sagebrush, \*Crop response, Grasses, Soil moisture meters, Moisture content, Sampling, Water loss, \*2-4 D, Herbicides. Identifiers: Plots.

This study's primary objective was to determine responses of the soil moisture regime to spraying

big sagebrush. Measurements were made over a period of 3 years following treatment, as grass production increased and subsequently diminished.
The study area was near Dubois, Wyoming, at 9,500 ft elevation with annual precipitation of 20 inches. Treatment consisted of spraying plots with 2,4-D in water at a rate of about 3 lb acid equivalent/acre. Gravimetric and neutron probe measurements were taken to determine soil moisture content. About 90% of the sagebrush plants on treated plots were killed by spraying. Net effect of the treatments was to depress total production below control plot levels. Spraying big sagebrush reduced the rate of soil moisture withdrawal. 75% of the difference in total moisture depletion occured within the 3-6 ft soil depth. An opposite effect in the second foot indicated that the increase in grass herbage production was most strongly reflected in that zone. Total evapotranspiration losses from the 0-6 ft soil profile were reduced about 14% over the 4-month growing period the second year after spraying. Big sagebrush grows in arid climates where the principles of the study could be applied. (Blecker-Ariz) W69-00379

WATER ENTRY, WATER USE AND SEASONAL-MOISTURE REGIMES IN FLOOD-IRRIGATED RIVERINA SOILS, Australia CSIRO, Div. of Soils.

J. Loveday, and D. R. Scotter. Australian J Exp Agr and Anim Husb, Vol 6, pp 296-304, August 1966. 9 p, 5 fig, 7 tab.

Descriptors: Soil physical properties, Flood irrigation, Soil moisture meters, \*Infiltration, \*Soil water, \*Water balance, \*Fertilizers, Irrigation practices, Bouyoucos blocks, Crop production, Moisture content, Sampling.

Identifiers: New South Wales, Australia, Seasonal moisture regimes.

An experiment was conducted in New South Wales, Australia to determine the amount of water used by irrigated winter pasture species and the water potentials of the soils supporting vegetation. The assessment of the soil water regimes were made by both the water balance and matric potential methods. Four types of treatments were made on 14 sites. Treatments consisted of normal fertilizer and normal irrigation, extra fertilizer and normal irrigation, normal fertilizer and frequent irrigation, and extra fertilizer and frequent irrigation. The matric potential, water use, and yield data suggested that soil water was below optimum for part of the growing season on most of the soils with the normal irrigation schedule. It was concluded that water entry characteristics largely covered the yield. (Affleck-Ariz) W69-00382

#### 04. WATER QUANTITY MANAGEMENT AND CONTROL

#### 4A. Control of Water on THE Surface

WATER SUPPLY FORECASTS FOR THE NORTHEASTERN UNITED STATES. Weather Bureau, River Forecast Center, ESSA, Hartford, Conn.

Yearly ESSA publications on January 1, February 1, March 1, and April 1. Vol. 10 No. 1-4, Jan-April,

Descriptors: Water supply, \*Streamflow, Northeast U. S., Seasonal. Identifiers: \*Forecasts.

These bulletins present ESSA Weather Bureau forecasts of total seasonal streamflow (November through May) to be expected from numerous

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watersheds in Maine, New Hampshire, and New York. The success of these forecasts is largely due to the time lag between winter precipitation and spring runoff, and to the lack of runoff produced by summertime precipitation. Forecasts are based on flow to date, precipitation to date and information on the snowpack at higher elevations. They are issued on the first of each month, January through April of each year. Five levels of possible flow or forecasts are given depending upon whether precipitation yet to fall through May 31st is equal to the minimum of record, the lower quartile, average precipitation, upper quartile, or the maximum of record. Forecasts in tabular form are summarized in narrative statements made for major basin drainages. (Strahl-ESSA) W69-00002

# STEVENS V SPRING VALLEY WATER WORKS AND SUPPLY CO (DAMAGES TO STREAM FLOW BY PUMPING).

42 Misc 2d 86, 247 N Y S 2d 503-512 (1964).

Descriptors: \*Judicial decisions, \*New York, Real property, Riparian rights, Pumping, \*Perennial streams, Percolating water, \*Damages, Water supply, Wells, Surface-ground water relationships, Obstruction to flow, \*Water sources, Ground

An award for damage to plaintiff's real property allegedly caused by defendant's interference with the source of a perennial stream was affirmed by the New York Supreme Court Appellate Term. The court held that testimony of plaintiff's expert witness and admissions of defendant's chief engineer and a ground water geologist who testified for defendant as an expert presented a jury question whether there was any correlation between the pumping of defendant's well and the lowering of the water table in another well and the drying up of a stream. A riparian owner's right to a natural stream flow proects him from diversion and diminution of a stream caused by arresting and collecting underground waters which percolate through the Earth to feed the stream, according to New York case law cited as authority for the decision. (MacMillan-Fla) W69-00006

#### CHAPPELL V WINSLOW (DIVERSION OF SURFACE WATER). State of North Carolina.

258 N C 617; 129 S E 2d 101-107 (1963).

Descriptors: Drains, Ditches, Surface drainage, \*Diversion, \*Natural flow doctrine, \*Surface runoff, Surface waters, Drainage water, Discharge (Water), Judicial decisions, North Carolina.

Lower land owners sought an injunction to stop upper land owners from accumulating, then discharging surface waters onto their lands. The trial court granted the injunction and the Supreme Court of North Carolina affirmed. Upper land owners have an easement, which requires lower owners to receive waters from the upper tract which flow naturally therefrom. The upper land owner may even increase and accelerate the flow. But he cannot divert the surface water so as to cause it to flow on lower land in a different manner and place. Following this rationale the trial judge decided that the defendants were not entitled to drain into a highway ditch surface water from ditches spaced about 250 feet apart. Such drainage would amount to a diversion of water from its natural flow, causing plaintiffs injury for which they had no adequate remedy at law. Plaintiffs were thus entitled to the injunction granted. (Harriett-Fla) W69-00020

STATE ROADS COMM'N PRESTON (DRAINAGE EASEMENTS). 226 Md 443; 174 A 2d 61-66 (1961)

Descriptors: \*Easements, Legal aspects, Surface runoff, Drainage systems, Ditches, Channeling, \*Drainage, \*Water, Judicial decision, Maryland.

The state acquired in 1954, by deed, strips of land adjacent to a roadway. Also acquired was a right to maintain on or across part of the grantor's land waterway necessary for drainage. The part of the grantor's land subject to the drainage easement was clearly marked on the plats. When the state widened the road in 1955, the additional surface runoff caused by the widening was directed by ditches and pipes onto grantor's lands, causing considerable erosion. The section of the grantor's land where the water and accumulated debris were dumped had not been marked on the plats. The grantors' obtained an injunction to stop the flow of water upon their land. The injunction was upheld on appeal, because the deed did not convey a drainage easement over all of the grantors' adjacent property, but over only those portions marked on the plats. (Harriett-Fla) W69-00024

#### V STATE (FLOODING HOLMES DRAINAGE INTERFERENCE). 32 Misc 2d 1077; 226 N Y S 2d 626-631 (1962).

Descriptors: \*New York, Surface runoff, \*Drainage water, Drainage, \*Water law, Judicial decisions, Riddance (Legal aspects), \*Damages.

Plaintiff brought an action for damages against the State of New York for flooding of the basement of his house caused by the construction of a highway bridge approach. The State defended the action on the ground that the design of the offending structure was in accordance with good engineering practive. The court, in holding for the plaintiff, stated that the fact that the design was in accordance with good engineering practice was not sufficient to remove liability of the State if its acts were in derogation of the rights of the claimant. As to the plaintiff's rights, the court said that a lower property owner (the state here) has a right to improve his property provided that the improvements are made in good faith and that the water is not collected and drained into the property. The court on the facts found that the defendant had gone beyond what it might do as a lower property owner without incurring liability. However, recovery was limited to injuries sustained up to the time of filing the claim. Patterson-Fla) W69-00032

#### WITHERS V BEREA COLLEGE (WITHHOLD-ING DRAINAGE WATERS NOT ACTIONABLE). 349 S W 2d 357-359 (Ky 1961).

Descriptors: \*Kentucky, \*Watercourses (Legal), \*Surface runoff, \*Drainage water, Drainage, Water law. Judicial decisions.

The case involves an action for damages and an injunction against the defendant Berea College for wrongfully causing a creek, as it passed through the land of the plaintiffs, to go dry during the summer months. The defendant had constructed a dam across a hollow and had impounded water in this area. The trial court held for the defendant on the theory that prior to the construction of the dam, the creek did not exist as a watercourse above the dam site. The court in the instant case agreed. It stated that although it is difficult to determine factually at what point water ceases to be surface drainage and becomes a natural watercourse, the law as to surface water is clear. At common law and Kentucky statute, the owner of land may collect and use as he pleases surface water that has not entered into a natural stream or definite waterbody. The court also stated that surface drainage becomes a natural watercourse where it begins to form a channel with a bed and banks, or sides and current, although the stream may be small and the flow intermittent. (Patterson-Fla) W69-00034

#### E J HOLLINGSWORTH CO V JARDEL CO (SURFACE DRAINAGE). 178 A 2d 307-310 (Del 1962).

Descriptors: Watercourses (Legal), Storm drains, Drainage, Ditches, \*Surface drainage, \*Paving, Pipes, \*Easements, Rain water, Surface runoff, Land development, Water law, Overflow, Flood damage, Rain, \*Storm runoff, Drainage systems,

Plaintiff brought this action to enjoin the defendant from collecting and dumping its surface water by means of a storm sewer into a pipe on plaintiff's land which in turn empties into a ditch running across plaintiff's property. Plaintiff's lands have served for innumerable years as the natural drainage area for the surface water of much of the surrounding land, including most of defendant's property. The court concluded that there had been created in defendant's favor a drainage easement across plaintiff's property. The issue was as to the defendant's rights in such easement. The defendant proposes to blacktop an area of about 27 acres. Only two-tenths of the water falling on defendant's land from any storm now flows off the ground. After the paving is completed nine-tenths will flow off. The court held that the extent of the burden which defendant will place on the easement is so great that plaintiff is entitled to a permanent injunction prohibiting defendant from permitting surface water from flowing into plaintiff's drainage pipe. (R. Smith-Fla) W69-00038

#### WINTERSTEIN V DIETRICH (NEW DRAINS WHERE OLD DRAINS EXIST). 369 Mich 415 120 N W 2d 254-258 (1963).

Descriptors: Michigan, Judicial decisions, Farms, Ditches, Drainage, \*Assessments, Subsurface drains, Drainage programs, Drainage districts, Administrative decisions

This case concerned the construction of a new drain over an older, yet servicable, drain. The issue was whether or not an adjoining landowner of the old drain could be fully assessed for the new drain where the old drain fully met his needs. It was held that he would be liable only for the actual gain to him. The new drain was to be underground while the old drain was an open ditch designed for farm drainage. Since the landowner here was a farmer, his liability was limited by that use. (Crabtree-Fla) W69-00041

#### PRICE V EMPIRE LAND CO (LAND DRAINAGE).

218 Ga 80; 126 S E 2d 626-630 (1962).

Descriptors: Surface waters, Surface drainage, \*Diversion, Natural flow doctrine, \*Discharge (Water), \*Flumes, \*Sumps, Diversion structures. Judicial decisions, Georgia, Surface runoff, Ditches, Drainage systems, Damages, Erosion.

The litigants owned adjoining lands. The defendants connected all surface drainage by a system of ditches, causing all waters to concentrate in three large sumps. The water from the sumps was discharged into a concrete flume which sloped to the plaintiff's property line. Plaintiff contended that this construction by the defendant caused the waters to enter plaintiff's lands with greater force than the natural flow, resulting in erosion damage to plaintiff's property. The trial court refused to grant an interlocutory injunction. The Supreme Court of Georgia acknowledged that there was evidence of damage to plaintiff's land, but decided no abuse of discretion resulted from the trial courts refusal to grant the interlocutory injunction. Plaintiff did not show that an injunction was necessary to protect the plaintiff's interest during pendency of the suit. (Harriett-Fla) W69-00042

# WATER QUANTITY MANAGEMENT AND CONTROL—Field 04 Control of Water on the Surface—Group 4A

BRAUN V FOXBORO CO (DISCHARGE OF SURFACE WATERS).

193 N E 2d 680-681 (Mass 1963).

Descriptors: \*Judicial decisions, \*Massachusetts, Water law, Legal aspects, \*Surface drainage, \*Surface runoff, Conduits, Reasonable use. Identifiers: Injunction

Plaintiff lower landowners sought to enjoin defendant upper landowners from discharging surface and contaminated water onto the lower land. The defendants had enclosed a brook which ran through their land in an eighteen inch pipe and connected it to a culvert installed under a road abutting on plaintiff's land. The natural drainage was from the defendant's land to plaintiff's land anyway. The facts as established in a master's report showed that the periodic increases in the flow of surface water were not attributable to the defendant and that it did not contaminate such waters. Also, only seventeen percent of the average flow in the drainage system was a result of the defendant's plant operation. The court held that this was a reasonable use and the lower court was correct in dismissing plaintiff's bill seeking injunctive relief. (R. F. Williams-Fla) W69-00063

# GRAVES V WIMPY (COMMUNITY DRAINAGE DITCHES).

For primary bibliographic entry see Field 06E. For abstract, see . W69-00068

# WILLIS V RICH (OBSTRUCTION OF DRAINAGE EASEMENT).

30 111 2d 323, 196 N E 2d 676-680 (1964).

Descriptors: \*Judicial decisions, \*Illinois, Remedies, \*Easements, Surface runoff, Surface drainage, Drainage systems, Drainage water, Surface waters, Drains, \*Tiles, Prescriptive rights. Identifiers: \*Injunctions.

Plaintiff, owner of a dominant estate, brought an action for a mandatory injunction to compel defendant to restore a mutual drain line across defendant's servient estate to its original condition. Defendant had built a retainer wall in the natural watercourse and diverted the flow into a 15 inch tile line which was inadequate to handle the flow of water. Flooding of plaintiff's property resulted. The trial court dismissed the suit for want of equity. On appeal to the Illinois Supreme Court, held, reversed. Plaintiff had repeatedly demanded the removal of the substituted drain system. Plaintiff had a drainage easement across defendant's land prior to the obstruction and such obstruction by the defendant will ripen into an easement itself unless the mandatory injunction is granted. (R. F. Williams-Fla)

# KIDWELL V BAY SHORE DEVELOPMENT CORPORATION (OBSTRUCTION TO FLOW TO SURFACE WATERS).

232 Md 577 194 A 2d 809-814 (1963).

Descriptors: Judicial decisions, Maryland, \*Obstruction to flow, \*Prescriptive rights, Civil law, \*Natural flow doctrine, Reasonable use, Damages, Highways, \*Landfills, Zoning. ldentifiers: \*Servitudes.

Plaintiff was a motel owner whose property adjoined a landfill owned by defendant and filled after plaintiff's motel was built. Ocean City was a thirdparty defendant joined because a highway bordered plaintiff's land and because Ocean City permitted the landfill operation. When plaintiff built the motel, his land was not in Ocean City. The landfill operation obstructed the normal flow of surface water from plaintiff's land. The court held, that

while Maryland is a Civil Law state as to surface waters, reasonable use could be applied for equitable reasons. Here, plaintiff secured partial relief and defendant was not held strictly liable for all damage caused. (Crabtree-Fla) W69-00072

# MILLER V SOMMERS (OBSTRUCTION TO SURFACE DRAINAGE).

11 Ches Co Rep 144-150 (1963).

Descriptors: Water law, Legal aspects, \*Pennsylvania, \*Judicial decisions, Surface runoff, \*Surface drainage, \*Reasonable use.

Identifiers: Upper owner, Lower owner, Restatement of Torts.

Plaintiff, upper landowner, averred that defendant, an adjoining lower landowner, had constructed a wall that blocked the drainage of surface water from plaintiff's land, causing flooding of his cellar. On these alleged facts, the defendant's demurrer was held properly overruled. Pennsylvania follows Sec 833 of the Restatement of Torts. Neither an upper or lower owner may divert or block the flow of surface water, willfully or negligently, so as to unreasonably interfere with the use and enjoyment of his neighbor's property. (R. F. Williams-Fla) W69-00073

# PURNELL V HOCK (OBSTRUCTION TO FLOW BY LOWER OWNER).

76 York 197-202 (Pa Com Pl 1963).

Descriptors: Pennsylvania, Judicial decisions, \*Natural flow doctrine, Relative rights, \*Obstruction to flow, Floods, Riparian land, Riparian waters, Permits, \*Boundaries (Property). Identifiers: Boundary walls, \*Act of God.

The defendant erected a boundary wall on both sides of a stream and artificially built up their land by adding soil. The effect of these improvements during a severe storm was to cause water to flood plaintiff's land. Defendant claimed that since such floods occur only every 10 years, the floods should be treated as Acts of God. This contention was denied and defendant lower riparian owner was made to remove obstructions harmful to plaintiff. (Crabtee-Fla) W69-00074

# BELLVILLE V PORTER (ACCRETION AS IT RELATES TO MAINTENANCE).

130 N W 2d 426-431 (Iowa 1964).

Descriptors: Iowa, Judicial decisions, Ditches, Drainage, Riparian rights, Obstruction to flow, \*Accretion (Legal aspects), Prescriptive rights, \*Dikes, \*Maintenance, Maintenance costs, Natural flow.

Identifiers: \*Sloughes.

This case involves two watercourses, one being a ditch and the other a slough. Plaintiffs contend overflow water from the ditch flows through the slough onto defendant's property, and defendant's removal of a dike across said slough caused interference with the flow of the ditch. Plaintiffs asked further relief for maintenance of the ditch and slough. It was held that the dike did not substantially interfere with the ditch flow, and that common riparian landowners have a duty to maintain the ditch because it is a natural watercourse. (Crabtree-Fla) W69-00077

# WAGNER V TIDEWATER OIL CO (DAMAGE RESULTING FROM STREAM FLOW ALTERATION).

191 A 2d 326-330 (Del 1963).

Descriptors: Delaware, Judicial decisions, \*Alteration of flow, Dikes, Riparian rights, Natural flow, Relative rights, \*Obstruction to flow, \*Embankmants, \*Tidal effects, Flood damage, Repulsion (Legal aspects), Streams.

A lower riparian owner was legally answerable to the adjoining upper owner for the increase in the amount of water which found its way onto the upper owner's land as a consequence of the diversion of a creek and the alternation of its physical characteristics caused by his action to improve his own land through erection of restraining dikes composed of soft mud. It was found that employees of the lower owner were aware of the character of the mud and should have anticipated the consequence of alteration of the normal course of the stream, casting significantly increased amounts of water on the land of the upper owner. (Crabtree-Fla)

#### ALLEN V ATLANTA (SURFACE DRAINAGE). 219 Ga 65; 131 S E 2d 549-551 (1963).

Descriptors: Drainage, Surface drainage, Paving, \*Ponding, Drainage systems, \*Sewers, Surface waters, Storm runoff, Rain water, Water law, Drainage water, Storm drains, Natural flow, Georgia.

The plaintiffs alleged that the defendant by its negligent construction and maintenance of its drainage system was discharging large amounts of surface water upon the lands of the plaintiffs; that a change in the natural flow of the surface water had been caused solely by the city in installing certain paving and curb lines; and that as a result, whenever it rains extensive damage has been occasioned by the flow of waters and by the consequent ponding of waters after the rains subside. Although the plaintiffs proved some of the allegations of their petition without any rebuttal testimony being of-fered, there was a conflict as to a material issue of the case, that is: upon whom did the responsibility for the unquestioned water damage to the lands of the plaintiffs rest. The defendant claimed the damage was a result of a faulty or clogged drainage sewer maintained by the City of Decatur. On the basis of this conflicting evidence the court affirmed the decision of the trial judge denying the plaintiffs prayers for an interlocutory injunction. (R. Smith-Fla) W69-00083

# FLOODS IN THE AREA OF VEGA ALTA AND VEGA BAJA, PUERTO RICO,

U. S. Geological Survey, Water Resources Division, Washington, D. C.

I. J. Hickenlooper.

U. S. Geol Surv Hydrol Invest Atlas HA-289, 1 sheet, 1968. text, map (scale 1:20,000), 2 fig, 1 tab, no ref.

Descriptors: \*Flood, \*Puerto Rico, Watersheds (Basins), Forecasting, Spoil banks, Flood plains. Identifiers: \*Vega Alta and Vega Baja, \*Hydrological atlas, \*Flood occurrence, Drainage basin.

Flooding from Rio Cibuco and its tributary, Rio Indio, is reported and illustrated by USGS Hydrological Atlas HA-289 (scale 1:20,000). A base map shows the topography (contour intervals 5 and 10 m) and displays: the boundary of the 1965 flood; area flooded December 11, 1965; and spoil banks placed during 1966 and 1953-58. Most of the area flooded by Rio Cibuco is planted in sugarcane or used as pasture. In 1966 a drainage canal was constructed from the urban area (flooded in 1965) to the Rio Cibuco channel. The December 11, 1965 flood on Rio Cibuco was the highest known, reaching an elevation of 5.6 m at Central San Vicente. It is estimated that floods will reach stages of 5.6 and 5.5 m at Central San Vicente on the average of once every 68 and 34 years, respectively. The flood profile base lines were drawn to conform with the general direction of the 1965 flood flow. Maximum depth of flooding can be estimated

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#### Group 4A-Control of Water on the Surface

from any point shown in the inundated area on the map. Water surface contours can also be determined by levels from a bench mark. (Llaverias-LISGS) W69-00100

CAPE FEAR RIVER BASIN, NORT CAROLINA; INTERIM REPORT ON RADLEMAN AND HOWARDS MILL PROJECTS. NORTH Army Corps of Engineers, Washington, D. C.

US 90th Congr, 2d Sess, House Doc No 343, 233 p, 1968. 4 fig, 1 plate, 18 tab, 37 ref, 5 attach, 2 ap-

Descriptors: \*Water supply, \*Recreation facilities, \*Floods, \*Flood control, \*River basin development, North Carolina, Water quality, Cost-benefit analysis, Municipal water.

Identifiers: Cape Fear River Basin, N C, Deep River Basin, N C

The flooding, public water supply and recreational potential of the Cape Fear River basin, North Carolina, were investigated and a plan for basinwide development of water resources is presented. The area includes the cities of Greensboro, High Point, and Burlington. The Randleman and Howards Mill dam construction projects in the Deep River Basin would provide for present and future needs, substantially supplementing the New Hope project, which is under construction. The projects would: increase the prevention of annual flood damages from 59% to 83%, provide 27,000 acre-ft of storage for water supply, provide 25,000 acre-ft of storage for water quality control, and provide excellent recreational facilities for an estimated 2,867,000 persons. First cost is estimated to be \$26,320,000 with annual cost of \$288,000. Annual benefits are \$2,115,000 with a benefit-cost ratio of 1.7 to 1. Data on the economics, population, hydrology, water quality, power needs, and municipal water needs of the area are tabulated. (Knapp-USGS) W69-00117

#### FLOOD PROFILE STUDY, SQUAW CREEK, LINN COUNTY, IOWA. U. S. Geological Survey.

US Geol Surv open-file rep, June, 1968. 13 p, 4 fig, 4 plate, 1 tab, 2 ref.

Descriptors: \*Floods, \*Flow profiles, \*Flood pro-Icota, \*Hydrologic data, Backwater, Floodways, Iowa, Watershed management.
Identifiers: Flood profiles, Cedar Rapids, Iowa.

Flood-inundation limits for a flood of 8,000 cfs under present channel and valley conditions are shown on maps scaled about 1 in. to 200 ft for an 18,000 ft reach of Squaw Creek, a tributary of Cedar River in Cedar Rapids, Iowa. Water surface profiles are also presented graphically for the 8,000 cfs flood and for a 5,600 cfs flood under 2 different assumed degrees of channel encroachment. Mean velocities for selected conditions at many sites are given in a table. The information presented is of particular value for planning agencies and groups involved in flood plain management. (Knapp-W69-00129

#### LABORATORY AND FIELD TESTS OF POND SEALING BY CHEMICAL TREATMENT,

Tennessee Univ., Knoxville, Dept. of Agricultural Engineering.

OWRR Project No. A-003-Tenn., Agricultural Experiment Station Bulletin 437, March, 1968, 14 p. 4 fig, 5 tab, 4 ref.

Descriptors: \*Seepage, \*Permeability, \*Reservoir leakage, \*Reservoirs, \*Darcy's law, Lagoons, Ponds, Farm ponds, Water holes. Identifiers: \*Pond sealing.

Over 500 permeability tests with 8 soil-dispersing chemicals were conducted on 9 Tenn. soil types. Sodium pyrophosphate treatments at 2 and sodium carbonate (soda ash) at 5 tons per acre were the most successful. These treatments costing approximately \$375 per acre for chemicals reduced the permeability of the 9 soils to from 1/10 to 1/100 of the permeability of identical but untreated samples. Laboratory test results suggest that at least 1 ft. of well compacted relatively impervious seal blanket over porous areas of pond floors is necessary to prevent rupture of the seal blanket under 10-ft. heads. 9 seriously leaking ponds were treated according to the best procedures developed in the laboratory. 8 of these treated ponds held well; and between Jan. 1 and Nov. 15, 1967, the mean ratio of minimum to maximum pond depths was 0.74. 1 pond developed serious leaks which were successfully repaired to a pond depth of 6 ft. The field tests substantiated the laboratory tests in that chemical treatments can, for certain situations, be effective in reducing reservoir seepage. (Author) W69-00224

#### BIG SIOUX RIVER, IOWA AND SOUTH DAKOTA.

Army Corps of Engineers, Washington, D. C

U S 90th Congr, 2d Sess, Senate Doc No 94, 73 p, 1968. 5 tab, 1 attach, 2 append.

Descriptors: \*Flood control, \*Channel improvement, \*Iowa, \*South Dakota, Missouri River Identifiers: Big Sioux River, Iowa, Sioux City, Iowa.

Flooding of the Big Sioux River, a left bank tributary joining the Missouri River just upstream from Sioux City, is described and a plan for flood control is presented. The Big Sioux River drains 9,565 sq miles in 3 states. The basin is used almost entirely for agriculture. The lower 5.5 miles of the river traverses a suburban residential area and presents a serious flooding and erosion problem. Annual flood damages are \$103,100 and are expected to reach \$174,900 with no control. A feasible plan includes channel straightening and widening, a cutoff at the lower end, and riprap at concave bends and bridge abutments. The cost is \$2,910,000, and the benefitcost ratio is 1.3 to 1. There are some recreational benefits. (Knapp-USGS) W69-00235

#### TANANA RIVER BASIN AT FAIRBANKS, ALASKA (FLOOD CONTROL PROPOSAL). Army Corps of Engineers, Washington, D. C

U S 90th Congr, 2d Sess, Senate Doc No 89, 96 p, 1968. 1 plate, 4 photo, 1 suppl, 1 append.

Descriptors: \*Flood control, \*Recreation facilities, \*Dams, \*Levees, \*Reservoirs, Cost-benefit analysis, Alaska, Floods, Flood damage. Identifiers: Tanana River, Alaska, Chena River,

Flooding in Fairbanks, Alaska, in the Tanana River Basin, is described and a proposal for flood control is presented. The Oest solution to the flood problem is a dam and reservoir on the main Chena River, a dam and detention reservoir on the Little Chena River, a levee on the tanana River, and a pumping plan0 in Fairbanks. The estimated first cost is \$113,000,000 of which \$111,000,000 is Federal and \$2,000,000 is non-Federal. The annual cost is \$261,000, and benefit-cost ratio is 2.7 to 1. The estimated annual recre \$250,000. (Knapp-USGS) recreational benefits are W69-00243

# ALHAMBRA CREEK, CALIFORNIA (FLOOD CONTROL PROPOSAL). Army Corps of Engineers, Washington, D. C.

U S 90th Congr, 2d Sess, House Doc No 336, 116 p, 1968. 1 fig, 2 plate, 2 photo, 1 attach, 3 append.

Descriptors: \*Flood control, \*Channel improvement, \*Diversion, \*California, Cost-benefit ratio, Floods, Flood damage. Identifiers: Alhambra Creek, California, Martinez, California

Flooding of Alhambra Creek, Martinez, California, was investigated and a plan for flood control is presented. Martinez is about 25 miles east of San Francisco. The drainage basin is about 5 miles long, averages 3.5 miles wide and has an area of about 16.5 sq mi. A serious flood problem exists; future damages are expected to average \$291,000 per yr. Flood control by channel improvement and diversion works is economically feasible. The total cost is \$8,900,000 of which \$8,000,000 is federal. Annual charges would be \$310,000 and benefits are estimated to be \$372,000 from reduction of damage, reduction in bank protection expense, and land enhancement; the benefit-cost ratio is 1.2 to 1. (Knapp-USGS) W69-00244

#### MARTIN COUNTY, FLORIDA.

Army Corps o Engineers, Jacksonville, Florida.

Army Corps of Eng, Surv-Rev Rep, 35 p, Sept 22, 1967. 1 plate, 3 tab, 1 suppl, 3 append, 1 disc.

Descriptors: \*Flood control, \*Water resources, \*Irrigation water, \*Florida, Levees, Canals, Locks, Recreation facilities. Identifiers: Martin County, Florida.

In response to requests that Martin County be included in the Central and Southern Florida Project, the plans were reviewed and it was found that a primary canal system of 60% standard project flood capacity would be an adequate outlet for the area's flood waters. The proposed plan would eliminate floods up to 30 yr magnitude, reduce stages and durations of larger floods, provide water control, and provide facilities for supplying irrigation water from Lake Okeechobee. The estimated benefitcost ratio is 15.3 to 1. The total cost is estimated to be \$16,220,900. (Knapp-USGS) W69-00246

#### WATER RESOURCES FOR CENTRAL AND SOUTHERN FLORIDA. Army Corps of Engineers, Jacksonville, Florida.

Army Corps of Eng, Surv-Rev Rep, 75 p, Feb 15, 1968. 12 fig, 1 plate, 5 tab, 1 suppl, disc.

Descriptors: \*Water resources, \*Flood control, \*Florida, Levees, Canals, Design flow Identifiers: Everglades National Park, Lake Okeechobee.

A restudy of the water supply and flood control project for central Florida, some of which is already constructed, finds that the authorized project will not meet water resource needs of the area after 1976, and presently existing works are part of the cause of a dangerously decreased flow of water into Everglades National Park. The most practicable plan is: (1) Raising Lake Okeechobee about 4 ft above presently authorized levels; (2) Provision of facilities for pumping excess water back into storage in Lake Okeechobee and the water conservation areas; (3) Provision of a system of canals, levees, pumping stations, and control structures for conveyance of water to demand areas; (4) Removal of humps from North New River and Miami Canals; (5) Provision of enough canal capacity at and below Tamiami Trial to permit design discharge at Structure 12; (6) Pumping first from agricultural canals when Lake Okeechobee must be drawn down; (7) Provision of needed recreational facilities. Estimated first cost is \$76,918,300, of which \$6,617,000 is for recreational facilities. Annual cost is \$4,691,700, of which \$698,000 is for recreation. The benefit-cost ratio is 2.8. (Knapp-USGS) from agricultural canals when Lake Okeechobee

# WATER QUANTITY MANAGEMENT AND CONTROL—Field 04

#### Control of Water on the Surface—Group 4A

FLOODFLOWS FROM SMALL DRAINAGE AREAS IN ILLINOIS: PRELIMINARY FLOOD-FREQUENCY RELATIONS,

U. S. Geological Survey, Champaign, Illinois.

US Geol Surv open-file rep, 10 p, 1968. 6 fig, 4 ref.

Descriptors: \*Floods, \*Frequency analysis, \*Small watersheds, \*\*Illinois, Streamflow forecasting, Hydrographs.
Identifiers: Flood frequencies.

Preliminary techniques are presented for estimating flood-frequency relations, up to the 50-yr recurrence interval, for streams in Illinois that have drainage areas no greater than 10 sq miles. The defined relations will be useful for the design or improvements of highway culverts and other hydraulic structures. Annual flood discharges for 61 stations with 12 yr of record and for 36 stations with 7 yr of record were analyzed with the respect to several basin characteristics. The drainage areas for these 97 stations range from 0.02 to 40 sq miles. Two estimating techniques are presented: One requires determination of only the size of drainage basin and a regional factor; and the other requires the determination of an additional parameter, channel slope. The relative reliability of the 2 techniques is approximated. An example is given to demonstrate a step-by-step procedure of applying the techniques by computing the 25- and 50-yr floods for a site on Crooked Creek in Union County, Illinois. Nomographs relate flood frequency, drainage area, slope, and regional runoff factor. (Knapp-USGS) W69-00254

#### SURFACE WATER LAW IN VIRGINIA. Virginia Univ, Charlottesville.

U Virginia L Rev, Vol 44, No 1, pp 135-150, Jan 1958. 16 p, 82 ref.

Descriptors: Remedies, Runoff, Surface runoff, \*Virginia, Local governments, Water law, Civil law, Judicial decisions, Legal aspects, \*Repulsion (Legal aspects), \*Surface waters, Riddance (Legal aspects), Reasonable use, \*Discharge (Water), Obstruction to flow, Relative rights, Diversions, Abatement, Rain water, Snow melt.

Three primary divisions of surface water law are discussed. These are the definition of surface water, the theories applied by the courts in this country, and the Virginia rule and its application. Surface water is defined as water which results from rains or melting snow and is diffused over the surface of the ground, forming no part of a natural stream or watercourse. Under the civil law rule, judicial enforcement of physical law is the key determinative in resolving conflicting interests of abutting property holders. Under the common-law rule, surface water is regarded as a common enemy which every landowner may fight off as best he is able. The reasonable use theory maintains that every landowner has the right to make reasonable use of his land, even though harm is caused to his neighbor. Virginia follows the common enemy con-cept, modified by the proposition that one must make use of his property so as not to injure the rights of another. The application of the Virginia le is discussed in detail. W69-00277

#### AIRPORTS, SUBDIVISIONS AND SURFACE WATERS.

Cincinnati Univ., Ohio. James Munro.

U Cin L Rev. Vol 30, No 4, pp 391-417, fall 1961. 27 p, 74 ref.

Descriptors: Surface waters, \*Surface runoff, Drainage water, Floods, \*Drainage systems, Drainage, Drainage practices, Excess water (Soils), Drainage patterns (Geologic), Damages, \*Flood damage, Streams, Channels, Ditches, Surface drainage, \*Repulsion (Legal aspects), Ohio.

The law of surface waters in Ohio is discussed. The decision of Mason v Vommissioners of Fulton County is analyzed for its modification of the law of surface waters. The modification per Macon permits an upper proprietor in the exercise of his servitude to cause an increase in flow, providing that the increased flow is placed in channels or watercourses already existing on the premises of the upper proprietor. But the change in an upper proprietor's right of servitude may be more illusary than real. One reason is that the Mason rule only applies to rural lands. The common enemy rule obtains with urban lands. The common enemy rule obtains with urban lands, which permits the lower owner to repel the surface water flowing onto his land. Also, recent decisions from lower Ohio courts undermine the additional protection of Mason. These decisions limit the increase of flow to the capacity of the stream. This new trend places the burden on the man who changes run-off patterns, because he runs the risk of paying damages for overburdening existing channels. W69-00295

### TAXATION OF LANDS COVERED BY NAVIGABLE WATERS USED FOR COMMER-CIAL PURPOSES.

State of Florida. For primary bibliographic entry see Field 06E. For abstract, see . W69-00319

#### WATER AND SEWER REGULATIONS.

State of Florida, Tallahassee. For primary bibliographic entry see Field 06E. For abstract, see . W69-00321

### PREDICTION MODELS FOR INVESTMENT IN URBAN DRAINAGE SYSTEMS, Virginia Polytechnic Institute, Water Resources

Research Center, Blacksburg. John W. Knapp, and W. J. Rawls. OWRR Report A-011-VA, August, 1968. 7 p.

Descriptors: \*Drainage systems, \*Economic predictions. Investment, \*Storm drains, \*Cost analywatersheds, Cost-benefit theory, \*Cities.
Identifiers: Prediction models, Urban drainage systems.

Study of data from over 100 small urban drainage systems led to formulation of prediction equations for the cost of conventional storm drainage facilities. Variables studied represented both physical features and design considerations. Regression techniques and factor analysis were used to screen the variables, to verify significance and independence, and to identify design patterns. Multiple regression techniques and principal components analysis were used in selecting and fitting the prediction models. Non-linear models provided the best predictors. One type to estimate total cost included independent variables describing slope, runoff factor, smallest pipe diameter, outlet capacity, and developed area; it can be used as a planning factor before preliminary layout of the system. Another used largest and smallest pipe diameters, developed area, total length of lines, and number of inlets and manholes; it can be used for estimating cost after preliminary design layout. Both types gave correlation coefficients over 0.95 and efficiency ratios over 70%. The models can be manipulated for use in comparative benefit-cost analysis. (Author) W69-00324

LEGAL DECISIONS INVOLVING WATER AND WASTEWATER.

Leo T. Parker. Water Works and Wastes Engineering, Vol 2, No 3, pp 63-64, Mar 1965. 2 p.

Descriptors: \*Judicial decisions, Water law, Legal aspects, \*Cities, \*Water pollution, Manuel aspects, \*Water works, Water conveyance, Con-\*Cities, \*Water pollution, Municipal duits, Damages. Identifiers: Damages (Legal aspects).

This article discussed several recent decisions regarding water works. In the first, Gordon v Provo City, 391 Pac 2d 430, it was held that when a city operates a water system as a commercial venture, it is liable for negligence in maintenance and operation (in this case, the placing of a water meter) regardless of whether the water meter is placed on plaintiff's land or in the street. Fields v Kansas City, 377 S W 2d 528, held city liable for injuries sustained by plaintiff when he fell into an uncovered manhole in an unlighted alley. Pieper v City of Scottsbluff, 126 N W 2d 865, held that in an eminent domain proceeding, the actual fair and reasonable market value included the value of gravel beds on the land. Anderson v Boise Water Corp, 372 Pac 2d 752, held officials of the water works negligent for not frequently inspecting an old water main. In conclusion, several cases on nuisance, and the measure of damages therefore are discussed. (Williams-Fla) W69-00334

#### DIFFUSED SURFACE WATER: SCOURGE OR BOUNTY.

Frank E. Maloney, and Sheldon J. Plager. Natural Resources Journal, Vol 8, No 1, pp 72-113, Jan 1968. 42 p, 242 ref.

Descriptors: Reasonable use, Remedies, Consumptive use, Surface drainage, \*Diversion, Water-course, \*Surface runoff, \*Repulsion (Legal aspects), \*Riddance (Legal aspects), Civil law, Nuisance (Water law), Stagnant water, \*Obstruction to flow, Riparian rights, Drainage districts, Easements, Judicial decisions, Water transfer,

Identifiers: Everglades National Park, Green Swamp (Fla), Central and Southern Florida Flood Control District, 1957 Water Resources Law.

Diffused surface water is water from rain, springs, or melting snow which lies or flows on earth's surface but which does not form part of water course or lake. This excludes natural water courses and flood waters connected thereto, lakes, ponds, marshes, swamps, and water artificially brought on property. Under civil-law rule, upper owner has easement over lower owner's land for natural drainage; under common enemy rule lower owner may keep water off land by any means. Reasonable use modification to both rules allows owner to deal with diffuse surface water as he wishes as long as his act is reasonable under all circumstances. Upper owner's liability is discussed for diversion, collection and discharge, raising land level, paving surface and drainage into natural watercourse. Lower owner's liability is considered for damming back water and raising land level. Legal action may be based on trespass, negligence and nuisance. Preferred remedy is injunction. Identification of injury as permanent or temporary determines mea-sure of damages. Defenses are contributory negligence, assumption of risk, statute of limitanegigence, assumption of risk, statute of limita-tions and prescriptive rights. Avoidable con-sequences or comparative negligence rule may reduce recovery. Priority of occupation is defense in some states. (Ausness-Fla) W69-00337

IOWA'S NEW WATER STATUTE - THE CONSTITUTIONALITY OF REGULATING EXIST-ING USES OF WATER,

For primary bibliographic entry see Field 06E. For abstract, see . W69-00338

COMPENSABLE VALUES IN FEDERAL TALKING' OF DAMSITES.

Stan L Rev, Vol 14, No 4, pp 800-810, July 1962. 11 p, 58 ref.

#### Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4A—Control of Water on the Surface

Descriptors: Judicial decisions, \*Navigable waters, \*Damsites, Federal government, Dam construction, \*Eminent domain, Water policy, Public benefits, \*Riparian land, Water law, Non-navigable waters

Identifiers: \*Navigation servitude, Constitutional law, \*Property rights.

The article focuses on the amount of compensation which the fifth amendment requires the federal government to pay for taking privately owned damsite lands. The navigation servitude, which stems from congressional power to regulate interstate commerce, holds that private ownership of property in and along navigable rivers is subservient to the federal interest. This servitude extends to flood control and hydroelectric projects. In United States v Twin City Power Co, the Supreme Court indicated that compensation must be paid for the taking of private property above the mean high-water mark, except for value which is at-tributable to the 'flow of the stream.' However, when viewed in light of United States v Virginia Elec Power Co, these cases raise questions as to what upland values will be deemed attributable to the flow of the stream. After a careful examination of the two cases, the author concludes that they are not inconsistent on the basis of Hohfeldian analysis. United States v Grand River Dam Authority, which extended the navigation servitude to nonnavigable rivers, is discussed. It is concluded that the social cost of exercising the navigation servitude should not be overlooked. (Patterson-Fla) W69-00339

SIMULATION TECHNIQUES FOR DESIGN OF WATER-RESOURCE SYSTEMS,

For primary bibliographic entry see Field 06A. For abstract, see . W69-00342

MANAGEMENT MODELS FOR WATER RESOURCE SYSTEMS,

Cornell Univ, Ithaca, N Y.
For primary bibliographic entry see Field 06A.
For abstract, see.
W69-00348

A SYSTEMS ANALYSIS OF THE LOWER GANGES-BRAHMAPUTRA BASIN, Harvard Univ, Cambridge, Mass. For primary bibliographic entry see Field 06A. For abstract, see .
W69-00350

#### 4B. Groundwater Management

THE RELATIONSHIP OF FLOODING AND SALINE WATER TABLES,

For primary bibliographic entry see Field 02F. For abstract, see . W69-00159

SUMMARY REPORT ON THE GROUND-WATER RESOURCES OF THE ANYANG CHON BASIN,

US Geological Survey. J. T. Callahan, S. I. Choi, and J. S. Han. J Geol Soc of Korea, Vol 4, No 1, pp 1-21, May 1968. 22 p, 2 fig, 4 tab, 7 ref.

Descriptors: \*Water resources, \*Groundwater, \*Hydrogeology, Aquifers, Water quality, Water yield, Discharge (Water).

Identifiers: Korea, Anyang Chon Basin, Pumping tests.

The groundwater resources of the Anyang Chon Basin which includes the industrial cites of Anyang and Yong Dung Po Ku in the Special City of Seoul, Republic of Korea are described. Total groundwater discharge is about 24% of the total average annual rainfall of 1,240 mm. Groundwater in storage in the basin is about 1,400 million metric tons; about 190 million tons in alluvium, 980 mil-

lion tons in saprolite, and 245 million tons in the crystalline rocks. Alluvial acqifers occupy about 85 sq kilometers in the basin. Bedrock consists of granite, gneiss, schist, quartzite, marble and limestone, ranging in age from Precambrian to Cretaceous. Normally the basin receives 70% of its precipitation during the summer growing season. The aquifers of the basin should yield at least 100 million metric tons of water per yr, a little more than double the pumpage in 1967. Existing pumpage is concentrated in Yong Dung Po and Anyang. To develop more ground water, well fields must be dispersed in other parts of the basin. Although the chemical, physical, and bacteriological quality of the ground water generally is satisfactory, its usefulness is threatened by industrial wastes. Waterborne disease epidemics result from improper construction of wells and the proximity of wells to pit latrines. (Knapp-USGS)

GROUND-WATER RESOURCES OF SAN JACINTO COUNTY, TEXAS,

U S Geological Survey. W. M. Sandeen.

Texas Water Development Board, Rep 80, 89 p, Aug 1968. 19 fig, 7 tab, 37 ref.

Descriptors: \*Groundwater, \*Aquifers, \*Appraisals, Wells, Hydrologic aspects, Water analysis, Texas.

Identifiers: \*San Jacinto County, Jasper aquifer, Evangeline aquifer.

In order to determine the availability of groundwater suitable for public supply, irrigation, and industrial uses in San Jacinto County, southeastern Texas, cooperative research was conducted by the USGS and the Texas Water Development Board. Much undeveloped fresh water was found to extend to depths of 1,600 ft in the county. More than half of the 1.2 mgd withdrawn in 1965 was discharged from flowing wells. About 40,000 acre-ft/yr (or 35 mgd of fresh water) could be pumped from the Jasper and Evangeline aquifers, two of three major hydrologic units. A smaller amount of water is available from sands below 400 ft, and from the Catahoula Sandstone, another hydrologic unit. The chemical quality of groundwater is suitable for most purposes. Some waters contain less than 100 ppm/dissolved solids content. The Evangeline aquifer supplies 70% of the water used; the Jasper aquifer, 25%. Stream base-flow measurements related to rejected discharge should be developed since this recharge now rejected by the outcrop areas is an important future water source. (Llaverias-USGS) W69-00240

#### PREDICTING RETURN FLOWS FROM IR-RIGATION.

Bureau of Reclamation, U S Department of the Interior, Denver, Colorado, Office of Atmospheric Water Resources.

For primary bibliographic entry see Field 05B. For abstract, see . W69-00248

# ROLE OF GROUND WATER IN TEXAS WATER PLAN,

Texas Water Development Board, Austin. Richard C. Peckham.

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5874, pp 137-152, Mar 1968. 16 p, 4 fig, 2 tab.

Descriptors: \*Water resources, \*Groundwater, \*Texas, Planning, Irrigation, Aquifers. Identifiers: Texas Water Plan.

The Texas Water Plan has given extensive attention to the availability of groundwater in aquifers of the state. By the year 2020, approximately 5,400,000 acre-ft of groundwater will be used in meeting the State's water requirements. There are approximately 5,000,000 acre-ft of water available an-

nually from the major aquifers of the State and approximately 365,000,000 acre-ft available from storage in aquifers which receive little or no recharge. (Author) W69-00250

UNCONFINED AQUIFER CHARACTERISTICS AND WELL FLOW,

Engineering-Science, Inc., Oakland, Calif., and California Univ., Davis.
For primary bibliographic entry see Field 02F.
For abstract. see.

PROBLEMS IN THE USE OF THE PUBLIC DISTRICT FOR GROUNDWATER MANAGEMENT, Wisconsin Univ, Madison.

Stephen C. Smith.

W69-00251

Land Econ, Vol 32, No 3, pp 259-269, August 1956. 11 p, 29 ref.

Descriptors: \*Groundwater, Legislation, State governments, Saline water intrusion, Overlying proprietor, Groundwater recharge, \*Surface-groundwater relationships, \*Groundwater mining, Water management (Applied), Water resources development, Coordination, Water districts, Artificial recharge, Water conservation, Pumping, Hydrologic cycle.

Many problems associated with the utilization of groundwater can be alleviated by instituting a program of groundwater management. In initiating such a program it is important that groundwater be considered as a component of the area's total water economy and that interrelationship between groundwater and surface water be considered. The execution of such a program requires the creation of some form of organization. One such form is the public district. The article indicates that the district can play a useful role as a local agency for groundwater management. Its geographic flexibility, intertemporal flexibility, concentration upon a single problem, ability to reflect local interests to obtain program adjustments, and ability to relate project costs to benefits commend the district as a groundwater management agency. On the other hand, if the problem is split into fragments, the district form of management may be used to inject an element of rigidity which will slow the process of social change. W69-00278

FLORIDA'S GROUND WATER: LEGAL PROBLEMS IN MANAGING A PRECIOUS RESOURCE.

Miami Univ, Miami, Fla. Frank E. Maloney, and Sheldon J. Plager. U of Miami L Rev, Vol 21, No 4, pp 751-776, 1967. 25 p, 3 fig, 3 map, 129 ref.

Descriptors: Groundwater, Percolating water, Aquifers, Overdraft, \*Saline water intrusion, Surface-groundwater relationships, \*Artesian wells, Reasonable use, \*Legal aspects, Legislation, Florida, Hydrologic cycle, Underground streams, Remedies.

Identifiers: Floridan aquifer, Biscayne aquifer.

There are four legal categories interrelated hydrologically: watercourses, diffuse surface water, underground streams and percolating groundwater. Groundwater is contained in permeable limestone beds called aquifers. In Florida two main aquifers are Floridan and Biscayne. Both water-table and artesian conditions exist. Groundwater problems are interference, overdraft, and contamination. Interference occurs between wells when cones of depression overlap. Overdraft results from pumping at a greater rate than intake of water from recharge area. Contamination includes pollution of groundwater by industrial, municipal or private wastes and salt water encroachment into aquifer -a serious problem in coastal areas. These are met by well-cupping stature, multipurpose water management districts, establishment of salt-water barrier

## WATER QUANTITY MANAGEMENT AND CONTROL—Field 04 Effects on Water of Man's Non-Water Activities—Group 4C

ines, and pollution control. Groundwater is dirided into underground streams and percolating and is presumed to be percolating unless shown otherwise. Surface water law covers underground treams. Percolating groundwater is covered by wo rules. Under common law rule, land owner, without malice or waste, may extract unlimited amounts and use it beyond overlying land despite narmful effects to neighbor. Under reasonable use rule, use is limited to beneficial purposes having reasonable relationship to land. W69-00280

DEVELOPMENT IN GROUND-WATER DESERT AREAS.

Arizona Univ., Tucson, Dept. of Hydrology and Water Resources.

John W. Harshbarger.

Ground Water, Vol 6, No 5, pp 2-4, Sept-Oct 1968.

Descriptors: \*Water resources development, Arid Descriptors: Water resources development, Arid lands, \*Groundwater mining, \*Deserts, \*Water management (Applied), Computer programs, \*Hydrogeology, Planning, Aquifers. Identifiers: Sahara, Atacama-Peruvian Desert,

Egyptian Desert, North American Desert, West

A summary of the development of ground water in several major deserts of the world during the period of 1958-1968 was given. The deserts included the Sahara, the Egyptian, the Atacama-Peruvian, and the North American deserts. Some basic principles for optimum groundwater management are listed. The Indus Basin of West Pakistan was given as an example of a model of sophisticated water management. It was concluded that physical resources and knowledge were available to develop desert areas, the computer and water systems analysis were available for guidance in water management, but man had to supply the necessary wisdom and judgment. (Affleck-Ariz) W69-00366

#### 4C. Effects on Water OF Man's Non-Water **Activities**

BYERS V HAMMAN (WATER DAMAGE TO ADJOINING LAND). State of Pennsylvania, Harrisburg.

46 Westmoreland 213-218 (Pa Com Pl 1964).

Descriptors: Judicial decisions, \*Pennsylvania, Spillways, Real property, Marshes, Water level fluctuations.

Identifiers: Equity.

A complaint was filed in equity in the Court of Common Pleas of Westmoreland County, Pennsyl-vania, charging that the construction of a spillway vania, charging that the construction of a spillway on defendant's land adjoining plaintiff's property had caused a marshy condition. Defendant answered by denying the alleged facts and raising affirmative defense of laches. Upon hearing, the court dismissed the complaint by decree his because the plaintiff failed to prove by clear and continuous auditors, that any activities upon port of convincing evidence that any activities upon part of defendant or her predecessors in title were the cause of the condition complained of. The court deemed it unnecessary to rule on the question of laches, the plaintiff having failed to prove a cause of action. (MacMillan-Fla)
W69-00004

# LAMB V DADE COUNTY (LOWER RIPARIAN RIGHTS V UPPER RIPARIAN RIGHTS).

159 So 2d 477-480 (DCA Fla 1964).

Descriptors: \*Riparian rights, \*Dams, \*Drainage systems, Saline water systems, Drainage districts, \*Reasonable use, Natural flow doctrine, Riparian

land. \*Obstruction to flow, Barriers, Relative

Defendant corporation owned, and paid taxes on, a portion of a canal used by plaintiff for primary drainage and water control. Defendant claimed exclusive rights to its portion of the canal and constructed a dam that materially altered the flow. Defendant wanted plaintiff to remove a dam built 17 years before to control salinity. The Court held that proprietor below has the right to receive from the proprietor above the usual flow of water substantially undiminished in quantity, and that the uppre proprietor has no right to unreasonably interrupt or obstruct the natural flow of water to the injury of the lower proprietor. It was established that defendant built the dam only to force plaintiff to remove the lower dam. This was held to be unreasonable. Plaintiff was given the right to maintain the canal within defendant's riparian land. (Crabtree-Fla) W69-00011

#### GAZIN V GLADWIN (OBSTRUCTION OF AN UNDEFINED WATERCOURSE). 220 N Y S 2d 861-865 (1961).

Descriptors: New York, Judicial decisions, Damages, \*Watercourses (Legal), Streams, \*Obstruction to flow, \*Landscaping, Landfills, Natural flow, Boundary disputes.

This was an action for damages resulting from the diversion and obstruction of a watercourse. Plaintiffs claimed that defendants raised the level of their land so as to obstruct the natural drainage from plaintiffs land. Plaintiff claimed that artificial drainage was made necessary by this obstruction. The issue was whether the water in question was a defined watercourse, such being a stream with a defined bed, bank, and sides and having a permanent source of supply. A defined watercourse may not be obstructed without raising liability for damages, but in the absence of a defined watercourse, no such liability exists. The evidence supported a finding that there was no defined waterourse and defendants had judgment on that issue. (Crabtree-Fla) W69-00019

#### TAYLOR V CONTI (NATURAL FLOW). 149 Conn 174; 177 A 2d 670-673 (1962).

Descriptors: \*Natural flow, \*Surface water, Connecticut, Erosion, Flood damage, Damages, Running waters, Dams, Land development, Water law, \*Silting, Slopes, Washouts, Natural streams, \*Flow augmentation, Soil erosion, Farm pond.

The plaintiffs own land with a house and barn erected thereon. In 1956, they completed the construction of a dam to form a pond for swimming and fishing in the waters of a brook crossing their property. In 1957 defendant purchased 73 acres of land for the purpose of subdividing it into building lots. This land was across the street and at a higher elevation than the plaintiff's property. The defendant had DeFelice cut down the hilly areas on the land, remove large quantities of topsoil and fill, and grade, reloam and reseed the land. The defendant's land, denuded of topsoil and with its grade changed to slope toward, rather than away from the street, eroded rapidly. Silt and gravel were washed across the street into the brook and were carried to the plaintiffs' pond. They were also washed onto the floor of the plaintiffs' barn. The trial court awarded the plaintiffs \$11,000.00 damages and enjoined defendant from diverting and increasing the flow of surface waters from his land onto the land of the plaintiffs. The court affirmed the holding of the trial court. (R. Smith-Fla) W69-00023

EPPLING V SEUNTJENS (OBSTRUCTION OF NATURAL FLOW). 117 N W 2d 820-825 (Iowa 1962).

Descriptors: Streams, \*Streamflow, Meanders, Alteration of flow, Natural flow, \*Ditches, \*Dikes, Damages, Flood damages, \*Obstruction to flow, Iowa, Judicial decisions.

Through plaintiff's land ran a stream which also ran through the defendant's adjoining land before reaching the river. This course of the stream on defendant's property had been changed prior to plaintiff's purchase of his property. An agreement between defendant and plaintiff's predecessor in title permitted defendant to construct a ditch and dike to channel the waters rather than let the stream spread out over defendant's fields in its natural course. This agreement reserved to plaintiff all remedies against defendant for obstructing the natural flow of surface water to plaintiff's damage. Plaintiff sought redress for damages to his crops and pastures, claiming that the construction of the ditch and dike and the placing of an obstruction in the ditch impeded the natural flow of surface waters. The trial court granted plaintiff the damages. The Supreme Court of Iowa reversed on the following grounds: (1) Defendant could turn the water that came onto his land from plaintiffs in any manner as long as he did not cast it upon plaintiff's land. (2) Plaintiff's allegations of defendant's obstructing the ditch was not supported by the evidence. (Harriett-Fla) W69-00025

#### CONRAD V WHITNEY (LANDFILLS ACROSS NON-NAVIGABLE WATERS). 141 So 2d 796-799 (Fla 1962)

Descriptors: \*Florida, Judicial decisions, \*Landfills, Non-navigable waters, Planning, Road banks, Riparian rights, Recreation, Ownership of beds, \*Bayou, Public rights, Right-of-way. Identifiers: Injunction.

This was a suit for a mandatory injunction to require defendants to remove a fill which they had placed across a natural non-navigable bayou upon which and under which both plaintiffs and defendants owned lands. The original owner of the lands in question subdivided same and platted streets, lots, and a waterway. The plat was not followed and when defendant's attempted to use the plat as reason for their filling operation, the court denied this reason and held that all riparian owners had common rights to the use of the bayou, and the fill must be removed. (Crabtree-Fla) W69-00029

#### RECTOR V TOBIN CONSTR CO (HIGHWAY CONSTRUCTION AND FLOODING).

351 S W 2d 816-823 (Mo 1961).

Descriptors: Missouri, Judicial decision, Crops, Damage, Highways, \*Landfill, Rivers, \*Obstruction to flow, \*Flood damage, Flooding, Right-ofway, State governments. Identifiers: Crop damage, Trespass.

This was an action for crop damage from flooding caused by the defendant contractor's dirt fill placed across a river bed in connection with highway construction. Defendant was liable in that state, sovereignty did not immunize him because the fill was not called for by contract, nor directed by the highway commission, or paid for by the commission. While there was a statute providing double damages where a person stops a watercourse without court permission, it was held applicable only to permanent obstructions and not to the case here of a temporary landfill. (Crabtree-Fla) W69-00043

ST ANDREWS CHURCH V TOWNSHIP OF LOWER PROVIDENCE (ACCELERATED SUR-FACE DRAINAGE).

414 Pa 40, 198 A 2d 860-863 (1964).

## Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

## Group 4C-Effects on Water of Man's Non-Water Activities

Descriptors: \*Judicial decisions, \*Pennsylvania, \*Surface runoff, \*Surface drainage, Water law, Legal aspects, Alteration of flow, Conduits, Cities.

The defendant township caused a roadway to be raised approximately 8 inches, thereby blocking the natural flow of surface water and causing accumulations of water to collect upon co-defendant's property. To alleviate this condition, the township installed a concrete drainage pipe under the roadway, causing the surface water which had previously flowed upon plaintiff's property (on the lower side of the road) in a diffused state to become a concentrated discharge of increased quantity. This caused flooding of plaintiff's property and ac-celerated filling of its cesspool. The court held that the chancellor's award of injunctive relief was proper. Pennsylvania follows the rule that one may not accumulate surface waters in an artificial channel and discharge them upon a lower owner, even if the quantity of discharge is not thereby increased. One justice dissented. (R. F. Williams-Fla) W69-00044

#### WILLIAMS V TRUNKLINE GAS CO (RIGHT-OF-WAY). 149 So 2d 160-164 (La 1963).

Descriptors: Land tenure, Water rights, Crop production, Levees, \*Flumes, Water conveyance, Bypasses, \*Right-of-way, \*Rice, Dams, Damages,

Plaintiff granted to defendant a right-of-way to lay, maintain and operate a pipe line across a tract of land owned by plaintiff. The property affected by this right-of-way had previously been leased by plaintiff to Frey for the purpose of farming rice on it. The agreement entered into between plaintiff and defendant provided for certain conditions and for damages for their breach. Frey had planted a rice crop and was flooding it when the construction of the pipe line began. There appears to be an irreconcilable conflict between the testimony of the witnesses and the trial court, apparently accepting the testimony of plaintiffs' witnesses, concluded that defendant had breached its contract with plaintiff by damming up the irrigation canal, by failing to provide for fluming of the water across the right-of-way so that water on the rice fields would remain level, and by failing to build levees along the right-of-way to keep the water from running off the land. The court affirmed the lower courts decision awarding the plaintiff damages. (R. Smith-Fla) W69-00046

#### KAPAYANIS V FISHBEIN (STORM RUNOFF). 181 N E 2d 653-654 (Mass 1962).

Descriptors: Drainage, Flooding, \*Storm runoff, Rain water, Storm drains, Precipitation (Atmospheric), \*Diversion structures, Surface water, Flow, Damages, Channels, \*Land development, Water law, Boundaries (Property), Massachusetts.

Plaintiff filed suit to enjoin the defendants from discharging water upon the plaintiffs' land and to obtain damages. Prior to the erection of a house on defendants property the plaintiffs had no trouble with water on their land. After the house was built water came from the roof and flowed onto the plaintiffs land. To alleviate the trouble the defendants constructed gutters with roof drains connected with a series of dry wells. These wells proved inadequate in times of heavy rains. The master found that the condition could be corrected by discharging the water from a gutter at the foot of the slope and connecting it with a street drain below the plaintiffs' land. The plaintiffs had this work done at a cost of \$525.00. The trial court enjoined the defendants from permitting water to be collected and to flow on plaintiffs' land and awarded plaintiff \$525.00 with interest as damages. The court modified this decree by striking out the provision for injunctive relief. (R. Smith-Fla) W69-00052

# SMITH V ATKINSON (DRAINAGE ENGINEER-

ING). 180 N E 2d 542-544 (Ind 1962).

Descriptors: Surface water, Water law, Flow, Damage, Runoff, Rain, Drainage, \*Rainfall-runoff relationships, Runoff coefficient, \*Drainage engineering, \*Watersheds (Basins), Ditches, Culgineering, \*Watersheds (Basins), Ditches, Culverts, Land developments, Indiana, Flood damage.

The plaintiffs alleged that they were the owners of Lot 12 in Avalon Hills, and that they had erected certain improvements on Lot 12, one of which was a crushed stone driveway passing over a natural ravine and watercourse. They further alleged that they had provided for the continued drainage in the watercourse by an 18 inch culvert. Defendants, the owners of the higher ground, had improved it by laying out 300 lots and building streets, roads, and drainage ditches. The plaintiff alleged that as a consequence of this improvement the defendants diverted and discharged onto and over plaintiffs property in great quantities the surface water from their land. The defendant claimed that no water waspermitted to flow into the watercourse which did not flow into it before. The court held that the evidence adduced at the trial was conflicting as to the facts material to the issues and thus did not inescapably lead to a result other than that reached by the court. The judgment for the defendant was affirmed. (R. Smith-Fla) W69-00053

#### CITY OF NORTHLAKE V CITY OF ELM-(PRESCRIPTIVE **RIGHTS:** DISCHARGE OF SEWAGE). 41 111 App 2d 190, 190 N E 2d 375-381 (1963).

Descriptors: \*Juudicial decisions, \*Illinois, \*Prescriptive rights, Surface drainage, Drains, Surface runoff, Cities, Storm drains, Storm runoff, Sewage, Sewers, Waste disposal. Identifiers: \*Injunctions.

The City of Northlake brought an action to enjoin the City of Elmhurst from allegedly allowing water and sewage to be discharged upon plaintiff's land. This discharge occurred when the flow in defendant's combined storm and sanitary sewer was too great to be accommodated by the outlet which led to Elmhurst's treatment plant. Defendant contended that it had a prescriptive right to such discharge. The court held that there was evidence that raw sewage was discharged on plaintiff's land and that neither a person nor a municipal corporation could be entitled to throw raw sewage on the lands of another. A permanent injunction was granted against the defendant, and it was directed to remedy the situation. The prescriptive right to discharge storm drainage was recognized. (R.F. Williams-Fla) W69-00055

# DEATON V CAUSEY (SURFACE WATER DRAINAGE - PRESCRIPTIVE PERIOD).

154 So 2d 267-269 (La 1963).

Descriptors: \*Louisiana, Surface waters, \*Surface drainage, Surface runoff, \*Prescriptive rights, Remedies, Damages, Judicial decisions. Identifiers: \*Prescriptive Period, Injunctive relief.

This action for damages and permanent injunctive relief arose as a result of the defendant's alleged excavation and grading of his lot, which caused a constant washing to plaintiff's property by reason of the change in the drainage of the surface water. The trial court held for the defendant on the basis of no cause of action and the running of the prescriptive period. The court in the instant case reversed the trial court. It held that the facts alleged in the case were sufficient, if proved, for injunctive relief to be accorded. The court also held that since the plaintiff alleged that the cause of the damage was more or less continuous and was recognized and acknowledged by the defendant, the prescriptive period would not be deemed to

have run. Even though the work was performed in 1926, where the operating cause of an injury is continuous, giving rise to damages from day to day, prescription has no application. (Patterson-Fla) W69-00056

ASSOCIATED CONTRACTORS STONE CO V PEWEE VALLEY SANITARIUM AND HOSPITAL (LIABILITY FOR ALTERING UNDERGROUND WATERS).

For primary bibliographic entry see Field 06E. For abstract, see. W69-00066

#### DEPARTMENT OF HIGHWAYS V ROUND-TREE (SURFACE WATER DRAINAGE OB-STRUCTION).

372 S W 2d 804-806 (Ky 1963).

Descriptors: Kentucky, Judicial decisions, Surface waters, \*Surface drainage, \*Obstruction to flow, Natural flow, Drainage, Highways, Easements, \*Prescriptive rights, Riparian rights, Relative Identifiers: Drainage obstruction, \*Catch basins.

This was an action by a highway department to enjoin the obstruction of drainage of surface waters from a highway catch basin onto defendant's lower adjoining land, wherein defendant counterclaimed for damages and injunctive relief. Defendant prevailed because he established that the catch basin tapped sources beyond the scope of any natural drainage easement, and that the highway department held no prescriptive right to discharge any additional surface water onto his land. (Crabtree-Fla). W69-00067

#### TIEDEMAN V VILLAGE OF MIDDLETON (SURFACE DRAINAGE BY SUBSURFACE DRAINS).

25 Wis 2d 443; 130 N W 2d 783-790 (1964).

Descriptors: Wisconsin, Judicial decisions, \*Surface drainage, \*Drainage effects, Storm drains, \*Prescriptive rights, Surface runoff, \*Embankments, Road banks, Cities, Obstruction to flow, Natural flow doctrine, Relative rights.

The evidence in an action to enjoin a city from constructing a storm sewer discharging water on plaintiff's land supported findings that all the water in the drained area would naturally find its way to a pond on plaintiff's land but for a railroad embank-ment and despite existence of other ponding areas, that water would have reached plaintiff's pond before the embankment was constructed. In that plaintiff had no prescriptive right to embankment and no new watershed was tapped or the water volume increased, defendant city prevailed. (Crabtree-Fla) W69-00078

#### HYDROGEOLOGY AT SHELBYVILLE, LINOIS - A BASIS FOR WATER RESOURCE PLANNING,

Illinois State Geological Survey. Keros Cartwright, and Paul Kraatz. Illinois State Geological Survey, Environmental Geology Notes, June 1967, Number 16, 15 pp, 3 map, 2 tab, 19 ref.

Descriptors: \*Aquifers, Hydrogeology, \*Water

resources, Hydrologic data. Identifiers: Shelbyville, Illinois, Kaskaskia river.

The impending construction of a multipurpose reservoir on the Kaskaskia river, northeast of Shelbyville, Ill., and its possible effect on the water resources of that city prompted the city to consider long-range plans for its water supply. To this end a study of the water supply, presently provided by an

#### Watershed Protection - Group 4D

quifer system, was made. The present well field and areas for future water resource development re outlined. A quantitative appraisal of the system; stimates of potential yield of the aquifer, projecion of water needs, and the economics of alternaive sources of water, was carried out. It is sugested that relocation of the wells presently used, ould triple the maximum daily pumpage; also the levelopment of other sites in the area could be used for additional water supply. A ground reser-roir of fairly high potential and the lake formed by he dam provide alternative sources of municipal water supply, giving Shelbyville considerable flexipility in water resource planning (Gargola-Thicago) W69-00179

# GEOLOGIC FACTORS IN COMMUNITY DEVELOPMENT AT NAPERVILLE, ILLINOIS, Ilinois State Geological Survey.

ames E. Hackett.

Environmental Geology Notes, Number 22, June 968, 16 pp, 4 fig, 11 ref.

Descriptors: Bed rock, Dolmite, Non structural alernatives, Flooding, \*Impaired water quality, \*Geologic investigations, \*Water supply, Ground water, Low flow, Stream flow, Drainage basin.
dentifiers: Naperville, Ill., West Branch Dupage River, Spring Brook.

Expansion of the city by incorporation of tracts of and for subdivision and for industrial and commerial use has resulted in expansion of community ervice facilities for water, sewerage disposal, and torm water drainage control. Because Naperville s surrounded by unurbanized land it will continue to grow, necessitating comprehensive plans to meet uture development needs. Information on geology, ground water resources, stream flow, and extent of flooding was gathered and related to various aspects of community development. Certain signifiant problems become evident: construction in areas subject to flooding and areas of poor drainage; impaired water quality due to the fact that Naperville is at the downstream end of the drainage basin in the county; legal and physical hindrances prevent other sources from being used, water supply must be had from underground sources. Considering these factors recommendations for future planning policies are outlined. (Gargola-Chicago) W69-00183

#### WATERFRONT HOUSING

San Francisco Bay Conservation and Development Commission, San Francisco, California.

San Francisco Bay Conservation and Development Commission, December 1967, 37 pp, 12 fig.

Descriptors: Bays, Future planning, Urbanization, Community development, Public rights. Identifiers: San Francisco Bay Area.

In recent years demand for housing in the San Francisco Bay area has greatly increased. The Bay area's accessibility and aesthetic appeal contribute to this increase, along with other factors such as rising incomes and increased economic feasibility. However, housing is not a necessary use of the shoreline and should not be allowed to displace those uses that of necessity must have waterfront locations. As an initial guide certain criteria should be followed, i.e. residential development should complement, not interfere with the value of the Bay as a habitate for fish and wildlife and the ability of the Bay to assimilate wastes. Planning for residential development should closely follow the adopted plans of the cities and counties around the Bay and contribute to enhancement of appearance and increase of public access. Other criteria proposals for development are discussed and twelve planning proposals for Bay area development are outlined. (Gargola-Chicago)
W69-00184 WATER FOR OREGON,

U.S. Geological Survey For primary bibliographic entry see Field 06D. For abstract, see . W69-00191

#### WATER SUPPLY AND POLLUTION CONTROL ASPECTS OF URBANIZATION,

Duke Univ., Durham, N. C., School of Law. Edward H. Bryan.

Law and Contemp Prob, Vol 30, No 1, pp 176-192. Winter 1965. 17 p, 2 tab, 18 ref.

Descriptors: \*Water pollution control, Water pollution effects, Water pollution sources, Water pollution treatment, Administration, Water resources development, \*Urbanization, \*Civil engineering, Sanitary engineering, \*Water supply, Water quality control, Cost comparisons, Waste water treatment, Research and development, Economics.

The need to develop new technical approaches and suitable legal and political structures for the control of pollution on a regional basis are discussed from a civil engineering viewpoint. Water supply and pollution are properly approached as aspects of a single problem. Water resources in terms of quantity are inexhaustible provided the quality of wastewater is sufficiently improved prior to its return to lakes and streams thus keeping waterways in satisfactory condition and enabling downstream users to withdraw water of useable quality. Water as a transport medium for wastes is an important function in community systems. Water pollution research still is but 'a drop in the bucket.' Costs are the greatest obstacle to effective pollution control. Urbanized America must have technically sound water management. Included tables illustrate the extent of industrial water consumption and the shift of population in Florida from rural to urban areas. W69-00290

#### 4D. Watershed Protection

AN APPRAISAL OF THE QUALITY OF SUR-FACE WATER IN THE SEVIER LAKE BASIN, UTAH, 1964,

U. S. Geological Survey, Water Resources Divi-

sion, Salt Lake City, Utah. D. C. Hahl, and J. C. Mundorff.

Utah Dep of Natural Resources Tech Publ No 19, 1968. 44 p, 8 tab, 15 fig, 2 plate, 30 ref, append.

Descriptors: \*Water quality, \*Surface waters, \*Hardness, \*Salinity, \*Irrigation water, Rivers, Sampling, Utah.

Identifiers: \*Sevier Lake Basin, Utah, \*Salinity hazard (Water), Sodium hazard (Water).

Dissolved solids concentration in the water of streams in the Sevier Lake Basin was found to range from 60-1,700 ppm (1964 water yr). The water is hard, of the Ca-bicarbonate type. In the East Fork and upstream part of Sevier River it had less than 500 ppm dissolved solids, mainly Ca, Mg, and bicarbonate, and hardness was 142-212 ppm. In the central reach of Sevier River, the concentrations of TDS and hardness increase. At Sevier Bridge Reservoir TDS concentration was 1,700 ppm, mostly Na and chloride, and hardness was 595 ppm. Salinity hazard is high to very high and sodium hazard is low to high. Concentration of TDS in the San Pitch River varies from 300 ppm upstream to 1,700 ppm below Gunnison Reservoir, and the composition changes from Ca-bicarbonate to Na-chloride. Salinity hazard is low to medium and sodium hazard is low. Below Sevier Bridge Reservoir, river water is diluted by springs and is less concentrated. Beaver River has less than 500 ppm TDS. Sediment concentrations in all streams range from less than 500 ppm 50% of the time to over 5,000 ppm only 5% of the time. Most sediments are carried in a few days a yr of high discharge. (Knapp-USGS)
W69-00091 EROSION CONTROL IN RELATION TO WATERSHED MANAGEMENT,

SCS, U. S. Department of Agriculture, Washington, D. C

William R. Moore, and C. E. Smith.

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR3, Pap 6126, pp 321-331, Sept 1968. 11 p, 4 fig, 2 tab. 8 ref.

Descriptors: \*Erosion control, \*Sedimentation, \*Watershed management, \*Multiple-purpose projects, \*Benefits, Channel erosion, Structural design, Pollution abatement, Water quality control, Water resources development.

Identifiers: \*Sheet erosion, \*Sediment deposition, Flood Control Act, Public Law 566.

A review is given of the modern concept of watershed management and what that management concept implies to different people in the light of different kinds of activities and objectives. Erosion control aspects are presented in considerable detail covering the significance and types of erosion and sediment problems, erosion control measures, and the small watershed approach with its benefits. Erosion and sediment problems in the U S annually cost \$1 billion loss or 1/4 of all soil and water losses. Sources and magnitude of sheet erosion, channel erosion, and wind erosion are described. Kinds and effectiveness of land treatment and structural measures are explained. Of 8,300 potentially feasible small watershed projects, about 325 were accorded needed installations under provision of the Watershed Protection and Flood Prevention Act, PL-566 (1954), and 6 million acres had been treated with erosion control practices by June 1966 with accumulated benefits totaling about \$52 million. (Lang-USGS) W69-00107

PUBLIC WORKS AUTHORIZATIONS, 1968-RIVERS AND HARBORS-FLOOD CONTROL AND MULTIPLE PURPOSE PROJECTS-PART

U. S. Congress Senate Comm on Public Works.

U S Senate 90th Congress, 2nd Session, Hearings Before the Subcommittee on Flood Control-Rivers and Harbors of the Committee on Public Works, April 22, 1968.

Descriptors: \*Legislation, Federal government, Political aspects. Public benefits, \*Government finance, Federal budgets, \*North Dakota, \*Missouri River, Flood control, Bank erosion, Soil erosion, Stream erosion, Erosion control, Bank protection, Stream stabilization.

The subcommittee on Flood Control-Rivers and Harbors met to consider Senate Bill S 537, 90th Congress, providing for additional bank stabilization work and maintenance on certain portions of the banks of the Missouri River between Garrison Dam and Oahe Reservoir, North Dakota. The bill would amend 77 Stat 840, which provided \$3 million of federal funds for flood control in the Missouri River Basin, to provide for an additional \$7 million. The subcommittee heard testimony from thirteen witnesses and received additional data submitted for the record. The testimony showed that portions of the banks of the Missouri River are subject to rapid erosion caused by sharp fluctuations of silt-free water released from Garrison Dam. The testimony also showed that many facilities as well as valuable farm land are in immediate danger from the erosion. Recommendations from the Secretary of the Army, Bureau of the Budget, and Office of the Chief of Engineers favored a \$2 million increase and no provision for maintenance. The final disposition of the bill is not stated. (Molica-Fla) W69-00325

#### Group 5A-Identification of Pollutants

#### 05. WATER OUALITY **MANAGEMENT AND PROTECTION**

#### 5A. Identification **OF** Pollutants

TURBIDITY MEASUREMENTS AS AN INDICA-TOR OF SOLIDS CONTENT OF NEUTRALIZED

MINE WATER, U. S. Bureau of Mines, Pittsburgh Mining Research Center, Pittsburgh, Pa.

Maurice Deul.

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 35-37, May 1968. 3 p, 2 tab, 7 ref

Descriptors: \*Acid mine water, \*Suspended load, \*Turbidity, \*Monitoring, Particle size, Waste water treatment, Suspension, Water quality. Identifiers: Neutralized acid mine water, Turbidity

monitoring.

Turbidity measurements are accurate indicators of suspended solids content only for a narrow range of sizes and solids composition. For acid mine waters neutralized with lime or limestone, the suspended solids content as estimated by a Jackson candle turbidity apparatus diverges greatly from the actual solids content determined gravimetrically. Experimental results presented show that turbidity measurements do not give an accurate estimate of the concentration of suspended solids in neutralized mine water effluent. The suspended solids that can be expected in neutralized acid mine water effluents vary in composition, particle size and shape, and color. Especially important, in view of the sources of error in turbidimetry, is the presence of substances like gypsum, hydrous iron oxides, and calcium carbonate which may change in particle size with time and variation in composition of the water treated. (Knapp-USGS) W69-00094

WATER RESOURCES DATA FOR PENNSYL-VANIA, 1965--PART 2. WATER QUALITY RECORDS.

U. S. Geological Survey, Water Resources Division, Washington, D. C.

U S Geol Surv Duplicated report, 1968. 211 p, 1 fig, 19 ref.

Descriptors: \*Water quality, \*Pennsylvania, \*Water chemistry, \*Data collections, Water analysis, Hardness (Water), Streamflow, Discharge (Water).

Identifiers: \*Chemical analysis (Water), \*Periodic observations.

Water quality data collected in Pennsylvania in 1965 are presented. Chemical quality, fluvial sediment, and water temperature data including concentrations of silica, aluminum, iron, manganese, calcium, magnesium, nitrate, total dissolved solids, and dissolved oxygen are tabulated. Temperature data were taken once daily and on continuous recorders. In addition to the list of references, a table of annual water-supply papers on quality of Pennsylvania waters is included. (Knapp-USGS) W69-00108

#### TODAY'S PROBLEMS OF INDUSTRIAL WASTE WATER POLLUTION ABATEMENT, R. Nebolsine.

Natural Resources Lawyer, Vol 1, No 1, p 39-57, Jan 1968. 19 p, 21 ref.

Descriptors: \*Pollution abatement, \*Water pollution, \*Industrial wastes, \*Waste water, Water pollution treatment, Water consumption, Costs, Water resources, Water utilization, Water pollution sources, Water users, Water quality, Federal government, Water pollution control, Waste water treatment.

The article deals with the industrial waste problems in relation to pollution problems from other sources. Remedies and methods of achieving them are outlined. The author considers water quality standards, the costs of pollution abatement to industries, a program for pollution abatement, and the means for encourageing industries to comply. He attempts to predict what future developments will concern the area. Through the combined efforts of industry and government the problems can be largly solved within the next few years. (Horner-W69-00328

OPTIMIZING SAMPLING INTERVALS,

Daniel, Mann, Johnson, and Mendenhall, DAMOC/WHO, Istanbul, Turkey.

Charles G. Gunnerson.

Proc IBM Sci Computing Symp Water and Air Resources Manage, pp 115-140, Oct 1967. 26 p, 14 fig, 2 tab, 17 ref, 2 append.

Descriptors: Analytical techniques, Data collections, Data processing, Evaluation, Frequency analysis, Frequency, \*Optimization, Regression analysis, \*Sampling, \*Time series analysis, Variability, \*Timing, Time lag, Hydrologic data, Dissolved oxygen, Statistical methods, Stream gages, Water quality control.
Identifiers: \*Spectral analyses.

Several methods of obtaining the optimum sampling intervals (minimum number of readings consistent with sufficient data collection) for various water studies were investigated. A plot of sampling interval vs the extreme, mean, and quartile values of DO and specific conductance for the Potomac River showed that little change resulted from sampling at intervals of less than 12 hrs. Frequency distribution plots of coliform bacteria on several rivers indicated optimum sampling intervals and timing for several study requirements. Departures from continuous data plots of stream flow for various selected sampling intervals gave optimum intervals for different sized drainage basins. Spectral analyses was applied to measurements of DO, specific conductance and surface currents for several rivers, with the results shown in figures. Regression analysis on sequentially selected data, and other sequential selection methods were discussed. It was concluded that spectral analyses appeared to be the best method of finding optimum sampling intervals. A bibliography and the theory and techniques of spectral analysis were appended. (Gysi-Cornell)

#### AN EARTH-SMELLING COMPOUND AS-SOCIATED WITH BLUE-GREEN ALGAE AND ACTINOMYCETES,

California Univ., Berkeley

Lloyd L. Medsker, David Jenkins, and Jerome F. Thomas.

Environ Sci Technol, Vol 2, No 6, pp 461-64, Jan 1968. 4 p, 4 fig, 14 ref.

Descriptors: \*Water analysis, \*Odors, \*Odor producing algae, Eutrophication, Alcohols, Actinomycetes, Cyanophyta, Spectroscopy, Gas chro-matography, Analytical techniques, Water pollution sources.

Identifiers: Proton magnetic resonance spectrometry, Oscillatoria tenuis, Ramman spectroscopy, Mass spectrometry, Symploca muscorum.

A compound, with earthy-musty odor similar to that often causing problems in food and water supplies, was isolated by preparative gas chromatography from a culture of actinomycetes (No 18) and cultures of 2 species of cyanophytes, Symploca muscorum and Oscillatoria tenuis. Actinomycetes were grown in medium (M sub 1 B sub 2); cyanophytes, in Hughes medium 11 (16 liters at 26-28 deg C and 200-300 ft-candles of light). The former yielded ca 200 microg/1 after 8-12 days at room temp; Symploca, 1 mg/vessel after 4-6 wk. Cyanophyte cultures were shown to be free of contaminating actinomycetes. Mass spectrum of the compound showed it to be identical with that of geosmin (C sub 12 H sub 22 0). Various analytical techniques (degradation, bromination, hydrogenation, analytical gas chromatography, high resolution mass spectrometry, infrared spectrometry and proton magnetic resonance spectrometry) showed that geosmin is a dimethyl substituted, saturated, tertiary alcohol with 2 rings in which the hydroxyl group is very sterically hindred. Structure of the ring system is unknown, but Ramman spectroscopy indicates that it may be similar to alpha-pinene. Geosmin is a colorless, viscous liquid, with camphorish odor (when concentrated) which becomes earthy upon dilution. A threshold odor of 0.05 microg/l is reported. (Eichhorn-Wisc) W69-00387

#### 5B. Sources of Pollution

#### WHITE V LONG (STREAM POLLUTION).

12 Ohio App 2d 136, 231 N E 2d 337-340 (Ohio Ct App 1967).

Descriptors: \*Odor, \*Public rights, \*Relative rights, \*Ohio, Natural streams, Effluent streams, Sewage treatment, Sewage effluents, Judicial decisions, Nuisance, Water pollution, Detergents, Phosphates, Potable water, Water purification, Biochemical oxygen demand, Local governments, Remedies

Identifiers: Injunctions.

Action was brought to enjoin operation of a sewage disposal plant discharging effluent in the form of treated, purified water into a small natural watercourse 200 feet upstream from plaintiff's property. Although odor was detectible 15 to 75 feet from the stream, it was not noticeable at plaintiff's house. The water contained effluent with a small amount of odor producing matter; some phosphates, due to detergents, which would cause foaming; and 6 parts BOD per million. It was potable for humans and livestock. There was practically no pollution and the effluent was below the standard permitted by the federal government. The plant was operated as part of the county sanitation system. Location, construction, and equipment were approved by government officials. The court applied the comparative injury rule, balancing public interest against plaintiff's injury, and refused to grant the injunction. (Rives-Fla) W69-00027

#### BARTLETT V **HUME-SINCLAIR** COAL MINIMG CO (POLLUTION CAUSED BY

351 S W 2d 214-218 (Mo 1961).

Descriptors: Missouri, Judicial decisions, \*Water pollution, \*Pollution abatement, \*Water pollution effects, \*Damages, Riparian land, Pollutants, Farms, Chemical precipitation, \*Coal mine wastes, State state transfer. Strip mine wastes.

This was an action for damages resulting from pollution of streams through coal mining operations. It was held that (1) testimony of lay witnesses was competent to establish pollution, (2) where injury is temporary or remedial, the measure of damages is not the depreciation in value but the depreciation of rental or usable value during the injury, and (3) that defendant's right to control the mine land was immaterial if pollution occurred on land under defendant's control. (Crabtree-Fla) W69-00033

GROUND-WATER HYDROLOGY PERTAINING TO SURFACE MINING FOR COAL-SOUTHWESTERN INDIANA, Indiana University, Water Resources Research

Center, Bloomington.

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 05

#### Sources of Pollution—Group 5B

Don M. Corbett.

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 164-189, May 1968. 25 p, 3 tab, 2 fig, 9 ref.

Descriptors: \*Spoil banks, \*Surface-groundwater relationships, \*Rainfall-runoff relationships, \*Recharge, \*Water storage, Stripmine lakes, Stripmine wastes, Coal mines Aquifers, Indiana.

Identifiers: Man-made aquifers, Environmental changes, Coal mining.

Cast overburden, resulting from strip mining for coal in Pike County, southwestern Indiana, in-creases surface permeability and forms extensive man-made surficial aquifers. Increased infiltration and storage materially reduce evaporation, flood flows, and crests in wet periods, and increase both base and storm flows during dry periods in summer and fall. Final cuts form lakes which are replenished by outflow from the adjacent castoverburden bodies. Precipitation and runoff data from 2 watersheds, one of which is extensively strip mined and the other not, are tabulated and compared. Storm runoff is 62% lower, and peak runoff is 56% lower in the mined than in the unmined watershed in wet periods. Maintenance of soil saturation and base flow in mined areas in dry periods increases both base and peak flow, but in the period of record, runoff intensity exceed 10 cfs per sq mile only once. (Knapp-USGS) W69-00093

SOURCES OF SALINE WATER IN THE UPPER BRAZOS RIVER BASIN, TEXAS,

U. S. Geological Survey For primary bibliographic entry see Field 03C. For abstract, see . W69-00136

WATER QUALITY AS AFFECTED BY A WYOMING MOUNTAIN BOG,
Department of Agriculture, Forest Service,

Laramie, Wyoming. David L. Sturges.

Water Resources Research, Vol 3, No 4, pp 1085-1089, Fourth Quarter 1967. 5 p, 1 fig, 3 tab, 7 ref.

Descriptors: \*Water quality, \*Bogs, Potable water, Wyoming, Peat, Rocky Mountain Region, Fluctuation, Effluent stream, Groundwater.

Identifiers: Wyoming mountain bog, Elk Creek bog, Location difference, Mountain bog.

Waters collected July through October 1965 at a Wyoming mountain bog were analyzed for potability and seasonal changes in calcium, magnesium, potassium, iron, and silica. Four locations were sampled: effluent stream, fissure locations in the bog, peat locations in the bog, and groundwater. The color and turbidity of peat water greatly exceeded that at other locations and the maximum levels established by the U.S. Public Health Service for drinking water. The dissolved mineral content of all waters was very low, and the waters were of excellent chemical quality. All waters contained coliform organisms, probably of a nonfecal origin in peat and fissure water. The concentration of minerals in peat water remained constant through the sampling period. Mineral concentrations in groundwater increased in September, when the water table was at a seasonal minimum, but decreased in October following water table recharge. Silica levels were higher than other ions at all locations; the highest levels were in peat water. (Seneca-Rutgers) W69-00199

PREDICTING RETURN FLOWS FROM IR-RIGATION.

Bureau of Reclamation, U S Department of the Interior, Denver, Colorado, Office of Atmospheric Water Resources.

Patrick A. Hurley. ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5838, pp 41-48, Mar 1968. 8 p, 3 fig, 3 tab, 3 ref.

Descriptors: \*Return flow, \*Irrigation, \*Surfacegroundwater relationships, Drainage effect Drains, Deep percolation, Evapotranspiration. Identifiers: Transient storage, Graphical solutions. effects.

An analytical method for computing return flow or drainage from irrigation applications is presented and discussed. Computations consider aquifer properties, drain specing, and deep percolation. A graph for determining the fractional part of percolation remaining in transient storage is included. By using the graph and simple digital procedures, realistic estimates of irrigation return flow can be determined. The method was used to determine monthly quantities for 13 yr of return flows in the Mesilla Valley, New Mexico-Texas. (Author) W69-00248

WATER AND WATER COURSES - POLLU-

Detroit Univ. Law School. Leonard J. Simasko. U of Detroit L J, Vol 16, No 4, pp 211-212, May

Descriptors: West Virginia, \*Pollution abatement, Municipal wastes, State jurisdiction, Water law, Legislation, Water pollution. Identifiers: Police power.

The West Virginia court held that a municipality could be enjoined by the State Water Commission from polluting certain rivers. City of Huntington v State Water Commission, 73 S E 2d 833 (W Va 1953). In matters of statewide interest such as watercourses a municipality can be compelled to carry out plans of the state and to perform duties imposed by the state. In addition to the enforceable interests of lower riparian owners with respect to quality and quantity of natural flow, the police power of the state provides a basis for statutory restrictions such as those here involved against pollution. That others are also polluting a watercourse or that a city is financially unable to comply with a court order is no defense. W69-00265

WATER PROBLEMS IN THE SPRINGFIELD-HOLYOKE AREA, MASSACHUSETTS - A LAYMAN'S LOOK AT WATER IN THE METROPOLITAN AREA,

U S Geological Survey For primary bibliographic entry see Field 03C. For abstract, see . W69-00293

PARTICULAR PROBLEMS OF WATER POL-LUTION UNDER NEW YORK LAW AND FEDERAL LAW. Buffalo Univ.

Buff L Rev, Vol 10, No 3, pp 473-506, Spring 1961. 34 p, 177 ref.

\*New York, \*Water pollution, Descriptors: \*New York, \*Water pollution, Remedies, \*Pollution abatement, Waste disposal, Riparian rights, Human pollution, Impaired water quality, Relative rights, Sewage disposal, \*Reasonable use, Natural use, \*Water pollution control, Financing, Economic feasibility, Financing feasibility, Industrial wastes.

Identifiers: International pollution control, Federal pollution control.

The basic criterion of the right of a riparian to pol-lute a stream under the common law of New York is that of reasonable use. This criterion is to be determined on a case by case basis. In each case, the reasonableness of the pollution is influenced by many factors. The important factors are whether the riparians are public or private, industrial or residential, the size of the stream, whether the stream is navigable or non-navigable, and the purpose for which the water is being used. The common law remedies for pollution are analyzed with a conclusion that the battle to control pollution by these remedies has been lost because of prescriptive

rights, the reasonable use doctrine, and the inaction of riparian owners to exercise their rights. The article comments generally on the New York Water Pollution Act of 1949, using cases to illustrate its major problem, which is financing. The specific pollution problems in New York are mentioned along with a discussion of Federal and International (Canada) controls, which points out that New York State is not a fervent pollution abater. W69-00304

RULES OF STATE BOARD OF HEALTH - POL-LUTION OF WATERS.

State of Florida, Tallahassee.

Fla Admin Code, Ch 170c-5, pp 51-54B. 6 p.

Descriptors: Drainage wells, \*Regulation, \*Administrative agencies, Water properties, Water quality, \*Florida, Standards, Water policy, \*Water analysis, Thermal conductivity, Color, Odor, Toxicity, Turbidity, Oxygen, Testing, Permits, Water pollution control.

This chapter deals with the classification of waters and the regulation of drainage wells. The waters of Florida are classified according to usage. The five classes of waters are: Class I - public water supply; Class II - shellfish harvesting; Class III - recreation, and propagation and management of fish and wildlife; Class IV - agricultural and industrial water supply; and, Class V - navigation, utility and industrial use. The criteria for these classes are set forth according to the following categories: sewage, industrial wastes, or other wastes; odor; pH; dissolved oxygen; toxic substances; bacteriological quality; temperature; deleterious; and, turbidity. Each class is defined in terms of the categories applicable to it. A permit is required for the use or drilling of any drainage well. Application for this permit must contain specified data. Certain drilling requirements must be met. Test wells and abandoned wells must be filled with cement. (McDermott-Fla) W69-00318

THERMAL POLLUTION OF WATER

Rutgers, The State Univ, New Brunswick, N J. Burton Davidson, and Robert W. Bradshaw Environ Sci and Technol, Vol 1, No 8, pp 618-630, Aug 1967. 13 p, 8 fig, 2 photo, 34 ref.

Descriptors: \*Analog computers, Biochemical oxygen demand, \*Dissolved oxygen, Fishkill, Stream improvement, Optimization, \*Simulation analysis, \*Thermal pollution, \*Temperature control, River systems, Water pollution control, Oxygen requirements, Effluents, Enthalpy.

Identifiers: Deterministic models, Purification effects, Material balance.

Simulation techniques were used to obtain the optimal stream temperature profile which resulted in maximum DO levels at every point downstream from a single source of pollution. An analog computer was used for the study. The one-dimensional, steady-state, deterministic model used was that derived by Pontryagin. The model consisted of three main elements; (1) continuous deterministic performance equations for BOD and DO (based on the work of O'Connor and Dobbins) and initial conditions; (2) a piecewise continuous decision vector function and constraints; and (3) an objective function (maximization of stream DO). Results of hypothetical examples for two intitial DO levels and four initial BOD levels were shown in graphical form. The internal consistencies of the optimal curves were checked by working the problems in reverse to obtain the BOD and DO material balances. It was concluded that hot effluents do not necessarily have an adverse effect on the DO level of a stream. (Gysi-Cornell) W69-00343

# Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources of Pollution

THE RELATION OF HUMIC COLOR TO IRON IN NATURAL WATERS,

Minnesota Univ., Minneapolis, Limnological Research Center.

Verh Int Verein Limnol, Vol 16, pp 477-484, Stuttgart, Germany. Dec 1966. 8 p, 5 fig, 2 tab, 4 ref,

Descriptors: Eutrophication, \*Humic acids, \*Iron, Water chemistry, Water quality, Color. Identifiers: Discoloration, Peptisation.

At pH and redox values of most natural waters, iron (Fe) is insoluble. Such waters, filtered through membrane filters and analyzed for Fe, show concentrations 8-9 orders of magnitude greater than the theoretic limit. Since natural waters highly colored with humic matter usually contain high Fe concentrations, it may be supposed that com-pounds responsible for the discoloration may also act to hold Fe in 'solution.' Humic waters were extracted chemically (treated with cation exchange resins, solvent-extracted, freeze-concentrated and dried). Fe, added to solutions of yellow acids (YA) so obtained, was rendered filterable to degrees varying with pH of the solutions, cationic composition of the medium, and nature of the functional groups of the YA. At pH 10, solutions of YA hold concentrations of Fe (ca 80 micromoles/mg YA) concentrations of Fe (ca 80 micromoles/mg YA) 13 times greater than those at pH 5. Cations with high valence tend to coagulate Fe in solutions of YA more extensively than those with lower valence. Chemical modification of functional groups of YA altered their holding capacity. These experimental data suggest that YA not only form complexes with Fe but also act through their -COOH functional groups to form protective sols (peptisation) of collodial Fe (III). (Eichhorn-Wisc) W69-00385

#### 5C. Effects of Pollution

# WILKINSON V HEALD (COST SHARING BETWEEN DRAINAGE DISTRICTS).

127 N W 2d 622-625 (1964).

Descriptors: Iowa, Judicial decisions, Outlets, \*Drainage districts, River systems, \*Repairing, \*Maintenance costs, Ditches, \*Cost sharing, Financing, Cost-benefit analysis.

Identifiers: \*Common outlets.

This was an action between two drainage districts. The issue was the allocating of payment for repairs to a drainage ditch in one of the districts. The lower district, where the repairs were made, claimed that the upper district should bear part of the cost because the repaired drain was a common outlet. The upper district objected to payment because the two districts were separated by I fourth of a mile, and therefore maintained that the repaired ditch was not a common outlet. It was held that the repaired ditch was a common outlet and that the upper district must pay part of the expense. (Crab-W69-00015

VAN BROCKLIN V GUDEMA (WELL WATER POLLUTION CAUSED BY NEGLIGENCE OF ADJOINING FARMOWNER).

For primary bibliographic entry see Field 06E. For abstract, see . W69-00058

# WILLIAMS V PENDLETON MFG CO (WATER POLLUTION IN NONNAVIGABLE CREEK).

244 S C 228-236, 136 S E 2d 291-296 (1964).

Descriptors: Ammonia, Chemical analysis, \*Nitrates, \*Chemical wastes, Industrial wastes, Water pollution, Riparian rights, South Carolina, Nitrogen compounds, Poisons.
Identifiers: Water Pollution Act, \*Cyanide, Cyanide, Cyanide nide poisoning, Nitrate poisoning.

Defendant's company operated a manufacturing plant four miles upstream from the land of plain-tiff's father. Defendant had discharged spent industrial dve stuffs into a creek flowing through this property for years. Plaintiff owned five cows which grazed this land. Four cows died of cyanide or nitrate poisoning within three hundred yards of the The fifth survived with treatment. It was held that there was sufficient evidence that there nitrates in the manufacturing plant's discharges to go to the jury. The judge properly excluded evidence of a test made of the creek one year prior to the incident. The judge, however, committed prejudicial error in charging the jury in accordance with the Water Pollution Act. was no evidence of a violation of this Act. Furthermore, causes of action arising from violations of this Act inure solely to the State of South Carolina. The Act was not intended to create new or enlarge existing common law or statutory rights for riparian owners or others. The case was reversed and remanded for a new trial. (McDermott-Fla) W69-00060

THE EFFECTS OF STRIP MINING ON THE MICROBIOLOGY OF A STREAM FREE FROM DOMESTIC POLLUTION,

Kentucky University, Department of Microbiology,

Lexington.

Ralph H. Weaver, and Harry D. Nash. Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 80-97, May 1968. 16 p, 5 tab,

Descriptors: \*Acid mine water, \*Aquiatic microorganisms, \*Algae, \*Aquatic bacteria, \*Aquatic fungi, Yeasts, Hydrogen ion concentration, Iron, Sulfate, Temperature, Kentucky.

Identifiers: Acid waste microflora, McCreary County, Kentucky.

The microflora of Cane Branch, McCreary Co., Kentucky, which drains a strip-mined area, and Helton Branch, which drains a similar but nonmined area, were studied to determine the biological effects of acid mine drainage. Numbers and types of bacteria, fungi, yeasts, and algae, from both surface and bottom samples, as well as temperature and pH were studied to learn the changes of ecology with dilution and recovery. These data are tabulated by season and stream. Iron oxidizing bacteria appear to be indigenous in acid mine water and directly associated with acid formation. Ferrobacillus ferroxidans was found in Cane Branch in all seasons, but only in summer in Helton Branch. The lowering of pH to 3.0-4.1 from 6.3-6.7, with an increase in sulfates and almost total elimination of bicarbonate alkalinity, resulted in the alteration of microflora in Cane Branch, primarily the establishment of F. ferroxidans. The role of fungi in stream chemistry is as yet unknown. Cane Branch algal growth and diversity of types increased with distance from the surface of pollution where Bumilleria, which is found only in streams with acid mine waste, was the only genus present. (Knapp-USGS) W69-00096

THE RELATIVE INFLUENCE OF IRON, SULFATE AND HYDROGEN IONS ON THE MICROFLORA OF A NON-ACID STREAM, Ohio State University, Faculty of Microbial and

Cellular Biology, Columbus. Reprints of Pap 2d Sump on Coal Mine Drainage Res, Mellon Inst, pp 64-79, May 1968. 16 p, 3 tab, 8 fig, 6 ref.

Descriptors: \*Acid mine water, \*Aquatic bacteria, \*Hydrogen ion concentration, \*Iron, \*Sulfate, Pseudomonas, Sulfur bacteria, Waste water (Pollution), Mathematical models. \*Flavobacterium, Identifiers: Heterotrophic aerobes.

The influence of acid mine drainage on the microflora of normal streams was studied to determine the extent of abatement required to restore acid polluted streams. A growth medium was used which simulated the stream nutritionally. Water composition was varied systematically in sulfate, ferric iron and pH. Survival of bacteria was correlated with variation of ionic composition and mathematical models were developed to fit the data. Relationships developed from the models were experimentally tested. The bacteria studied, Pseudomonas (M-1), Flavobacterium (M-2), and Bacillus (M-3), grow when pH is above 5.3 if iron levels are in the range 1-100 mg per m1 and sulfates in the range 50-500 mg per m1. Growth in-creased with iron content when pH was over 5. The effect of sulfate was nonlinear and dependent on acidity; the most important variable was pH. Control measures should emphasize removal of acidity and sulfate by use of sulfate-reducing microbes, and prevention of pollution should also be emphasized. (Knapp-USGS) W69-00098

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STOCHASTIC MODEL FOR POLLUTION AND DISSOLVED OXYGEN IN STREAMS,

Virginia Polytechnic Institute, Blacksburg Richard P. Thayer, and Richard G. Krutchkoff. Water Resources Res Center Rep, Va Polytech Inst, 1966. 109 p, 14 fig, 10 tab, 13 ref.

\*Water Descriptors: \*Water pollution, processes, \*Mathematical studies, \*Stochastic \*Statistical models, \*Synthetic hydrology, Biochemical oxygen demand, Chemical oxygen demand, Dissolved ox-

ygen. Identifiers: Stochastic stream-pollution model.

A stochastic model was developed to provide a joint density function at any point downstream for both pollution and dissolved oxygen in a stream when initial conditions of BOD, COD, pollution inflow rate, pollution and oxygen decrease rate, and reaeration rate are assumed. The digital computer programs used are included. The method was checked against observations of oxygen content and scatter of data on the Sacramento River, and the results agreed. The model was also checked by mixing sugar and other nutrients with pond water, aerating the misture in cans, and monitoring changes in oxygen demand and pollution with time.
(Knapp-USGS)
W69-00141

ECONOMICS OF WATER POLLUTION,
Dept. of Agriculture, Economics Research Service.
Joseph P. Biniek, and Gary C. Taylor.
Florida Univ., Institute of Food and Agri Sci, Water Research Needs: An Economic Appraisal, Pub No 3, pp 57-70, Dec. 1967. 7 p, 13 ref.

Descriptors: \*Cost-benefit analysis, Pollutants, Radioisotopes, Sluices, \*Federal Government, Estuarine environment.
Identifiers: Economics, \*Water pollution.

Water quality is a subset of the larger field of environmental quality. There is a direct inter-relationship between polluted air, soil, and water. Water is an economic problem since it is characterized by dimensions of demand, supply, location, time, and quality. Water pollution is defined as an undesirable change in the relevant characteristics of a water supply. A classification of the origin of pollutants were listed. The costs and benefits of water pollution are inflicted by one decision making unit and borne by another without any price signals being registered in the normal market price structure. Hence, disadvantaged parties result and they try to solve the problem politically. The weighing of benefits and costs to affected parties and the design of optimizing solutions through various programs, public and private, is the economic content of the political problem of water pollution. Four major kinds of economic research appear to be needed in the water pollution area. These include economic surveys, analyses of critical problems, studies of institutions, and research to improve the analytical abilities of researchers. A partial list of sources of research data was given. Grossman-Rutgers) W69-00172

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 05

## Effects of Pollution-Group 5C

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY

Stanford Univ., Stanford, California.

Gene E. Willeke.

Stanford U., Program in Engineering-Economic Planning, Report EEP-29, October 1968.

Descriptors: \*Water pollution effects, \*Social impact, Psychological aspects, Water sports, Public health, California, Attitude, Behavior, Flotsam, Ethics, Water Quality Act, Recreation demand, Intangible benefits, Turbidity, Water temperature. Identifiers: Communication, Survey research, Discriminant analysis.

A 914-case sample survey was conducted in San Francisco Bay Area to measure attitudes toward and perception of water pollution in the Bay and to determine what effects these attitudes and perception have on use of the Bay for recreation. Information seeking, source credibility, and influence of conservation organizations were also studied. Half the respondents cited pollution as an unappealing feature of the Bay; half considered the Bay polluted. Information received, sex, and household income were good predictors. 27% believed contact with Bay water could be harmful; 28% were unwilling to eat fish caught in the Bay. Many of these same persons do not participate in recreational activities on the Bay because of perceived pollution. 24% gave pollution as a reason for not using the Bay (swimming, 20%; water skiing, 5%; fishing, 2%; boating or sailing, 2%). 1% said they had become ill or suffered harmful effects from contact with Bay water. Policy implications include need for better public information programs and more use of qualitative quality parameters. Water quality seems to be insensitively related to recreational use of a water body. (Author) W69-00215

THE EFFECT OF PUMPED-STORAGE RESER-VOIR OPERATION ON BIOLOG PRODUCTIVITY AND WATER QUALITY, BIOLOGICAL

Virginia Polytechnic Inst., Blacksburg. S. E. Neff, and G. M. Simmons, Jr. OWRR Project No. A-012-VA, Aug 1968. 26 p, 3 fig, 2 tab.

Descriptors: Coliforms, Effluents, Industrial wastes, Sewage effluents, Limnology, Water temperature, Chemical properties, Primary productivity, Pumped-storage, Reservoirs, \*Reservoir operation, \*Eutrophication, Radio carbon, Thermal stratification, Water pollution effects.

stratification, Water pollution effects. Identifiers: Virginia, Smith Mountain Lake, Carbon-14 method

Smith Mountain Lake, Virginia is a pump-storage impoundment in which quantities of water are recycled on a daily and weekly basis. The reservoir behaves as a warm monomictic lake. Annual temperature and oxygen distribution show tendencies toward eutrophy. Recycling affects the stratification of the reservoir in summer and causes mixing of water in the vicinity of the dam. Effects of mixing can be observed up to 6.5 miles from the dam.

Primary productivity estimates at four stations using the carbon-14 method range from 68. to 575. milligrams carbon/meter squared/day; these yields compare favorably with mesotrophic lakes. Municipal effluents are rapidly producing changes in the upper parts of the reservoir. Productivity esti-mates (1800-2200 milligrams carbon/meter squared/day) in those areas reflect enrichment and eutrophic character of the water. Coliform counts also confirm enrichment and nature of the effluent. Some correlation between the standing crop of net phytoplankton and productivity estimates was ob-W69-00230

CORNELL SCIENTISTS SEE THERMAL POL-LUTION OF CAYUGA LAKE BY PLANNED NUCLEAR POWER PLANT, Cornell Univ., New York. A. W. Eipper, D. E. Arnold, and W. T. Bell.

The Conservationist, Vol 23, No 1, pp 2-5, 36-37, Aug-Sept 1968. 6 p, 1 map, 2 photo.

Descriptors: \*Thermal pollution, \*Thermal powerplants, \*New York, Nuclear reactors, Thermal stratification, Epilimnion, Hypolimnion. Identifiers: Cavuga Lake, New York

The present status of Cayuga Lake, the predicted effects of a proposed nuclear power plant on its thermal and nutrient structure, and the predicted impacts of these changes on the aquatic environment are described. Power plant design modifica-tions similar to those already in use elsewhere at other such plants to eliminate thermal pollution are suggested. Cayuga Lake is 38 mi long, has a mean width of 1.7 mi, a surface area of about 66 sq mi, a maximum depth of 435 ft, a mean depth of 179 ft. and a volume of 331 billion cubic ft. The mean flushing time is 9 yr. The lake is thermally stratified in summer; the temperature in the epilimnion is 50-73 deg F and in the hypolimnion, 40-43 deg. Millikin Station, the steam power plant now operating, has a heat output of 1.3 billion BTU per hr. The proposed nuclear plant would have a heat output of 6 billion BTU per hr in a continuous water flow of 9,000 gal per sec. This would cause earlier thermal stratification, algae production, and oxygen depletion in the hypolimnion; such conditions will last longer, accelerating eutrophication. Impoundment of cooling water, the use of cooling towers, and closed-circuit cooling towers with forced-air circulation eliminate thermal pollution where they are now used and are suggested for the power stations on Cayuga Lake. (Knapp-USGS)
W69-00241

PHOSPHATE FIXATION IN ORGANIC LAKE SEDIMENTS,

Cornell Univ., Ithaca, N. Y., Conservation Dept. Carl L. Schofield, Jr.

OWRR Project No. A-019-NY, Technical Report No 13, Cornell Water Resources and Marine Sciences Center, September, 1968.

Descriptors: \*Oligotrophic lakes, \*Phosphorus, Sediments, Eutrophication.

The mechanisms of phosphate fixation in organic sediments were studied in four oligotrophic lakes of the Adirondack Mountain region of New York. The forms of phosphate present were determined by sequential extraction, utilizing solvents selective for the various phosphates. Iron phosphates and occluded forms were dominant in oxidizing situations whereas aluminum phosphates were prevalent in reduced sediments. Aluminum phosphates are not as mobile as iron bound phosphates, being stable under reducing conditions. Organic phosphorus was high in all the sediments examined. Phosphate saturation was noted in one case where the sediments were largely autochthonous and low in iron and aluminum. The high soluble phosphate content in this system was conducive to higher productivity due to the high ratio of sediment area to water volume, weak thermal stratification, and low flushing rate. (Author) W69-00271

A MODERN APPROACH TO THE STUDY OF ESTUARIES, WITH SPECIFIC REFERENCE TO THE DUWAMISH RIVER, WASHINGTON,

Washington Univ., Seattle.
Denny M. Miller, J. A. Wetherall, and William H. Lenarz.

Sponsored by FWPCA. Transactions of the Thirtysecond North American Wildlife and Natural Resources Conference. Vol. 32, pp. 165-173, March 1967. 9 p, 1 fig., 4 ref.

Descriptors: Water pollution, Estuarine fishes, Computer models, Simulation analysis, Water quality, Mathematical models, Chinook salmon, Smolt, Mortality, Distribution, Growth rates, Marking techniques.

Identifiers: Time series analysis, Spectral analysis, BOMM, Co.

A synthesis of new and old methods is providing an effective approach to the study of complex ecological problems in the organically enriched Duwamish

Estuary, Washington. Time series analysis and computer simulation techniques will be used to build abstract models of the estuarine environment. The models may be used to predict temporal and spatial changes in environmental processes and may be a valuable tool for the management of certain fisheries. Tow net and a new mass-marking technique provide a means of quantifying information on the distribution, growth, abundance and mortality of juvenile chinook salmon in estuarine waters. In studies of the survival of downstream migrant salmon, survival estimates may be markedly biased unless the sampling procedures used are designed with particular attention to fish behavior. Simulation models may be used to estimate bias and to design sampling strategies that will reduce bias in survival estimates. (D. M. Miller-Wash) W69-00272

WATER POLLUTION--STATE CONTROL COMMITTEE.

Vanderbilt Univ., Nashville. School of Law.

Vand L Rev, Vol 17, No 3, pp 1364-1374, June 1964. 11 p, 55 ref.

Descriptors: Water pollution, \*Water pollution control, \*Pollution abatement regulation, \*Administrative agencies, Legislation, \*Permits, Water pollution effects, Discharge (Water), Pollutants, Water quality control.

Identifiers: Proposed model act.

Many states have adopted some form of centralized administrative control of water pollution. The type of control is usually categorized as either an irrational agency or a rational agency. The distinguishing feature of an irrational agency is its assumption of overall supervision of existing agencies. The rational agency, on the other hand, takes over all pollution control in the state. Preferred is the irrational agency, because it is able to ingest different kinds of technical and non-technical knowledge and is able to cut across many lines of interest. An act should not specify what waters it will apply to for this circumscribes the power of the agency. A permit system is an effective way of controlling the discharge of water. All persons who are discharging or plan to discharge water must apply for permits. The applications must contain a description of the kinds and amounts of water with mention of treatment facilities. The agency or central committee shall grant permits after studying applications. Those refused a permit may obtain a hearing. W69-00283

ENZYMATIC DEGRADATION OF DDT BY AQUATIC ORGANISMS, Cornell Univ., Ithaca, N. Y., Dept. of Entomology

and Limnology.

Roger G. Young.

OWRR Report A-015-NY, Cornell Resources and Marine Sciences Center, August 1968. 7 p, 1 tab.

Descriptors: \*Enzymatic degradation, \*Insecticides, Aquatic organisms, Aquatic microorganisms.

The objective of the research was to determine whether a number of mammals, fish and microorganisms had enzymatic capabilities to degrade DDT to DDE. The results of experiments involving yellow perch, brown trout and rock bass indicate that fish possess the necessary enzymes to give some degree of protection in DDT contaminated water, although more species variation might be observed in a broader survey. Preliminary tests were made to determine whether metabolic conversion of the insecticide DDT could be observed in pure cultures of some common algae. The two genera studied were Chlorella vulgaris and Ankistrodesmus flacatus. Conclusive evidence for DDT breakdown was not found in these preliminary tests. (Neno-Cornell) W69-00310

# Field 05-WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5C-Effects of Pollution

THE HIDDEN FLORA OF A LAKE,

Hebrew University of Jerusalem. Menachem Rahat, and Inka Dor Hydrobiol, Vol 31, Fasc 2, pp 186-192, 1968. 8 p, 1 tab. 27 ref.

Descriptors: \*Lakes, Plants, \*Algae, \*Salinity, Irrigation effects, Drainage effects, \*Sampling, Algae toxins, Saline water, Equilibrium, Biological communities, \*Aquatic algae, Halophytes.

A survey was conducted to determine hidden algal flora of Lake Kinneret (Sea of Galilee) in the Jordan Rift Valley, Israel, which would dominate in a rise of salinity due to disturbance of present equilibrium from drainage for irrigation. The chrysomonad Prymnesium parvum which caused toxic blooms was of particular interest. Water samples were selectively enriched for halophilic algae with an inorganic salt medium. A radical change was observed. Algae rare or unknown to the lake were present. Representation of the algal groups was as follows: 7 species belonged to Chlorophyceae, 8 species to Dratomeae and 15 to Cyanophyceae. Prymnesium parvum was present in 6 of the 27 samples. Thus it was indicated that a sufficient rise of the lakes salinity would result in a predominance of halophilic algae and the presence of Prymnesium parvum forms a potential danger of toxic blooms. (Affleck-Ariz) W69-00360

RESISTANCE OF TILAPIA NILOTICA L TO HIGH TEMPERATURES,

Cairo Univ., Cairo, Egypt, Zoology Dept.

H. M. Bishai. Hydrobiol, Vol 25, No 3-4, pp 473-488, 1965. 16 p, 5 tab, 2 fig, 57 ref.

Descriptors: Temperature, Thermal stress, \*Heat resistance, Fish physiology, Larvae, Fry, \*Acclimatization, Resistance, \*Fish behavior, \*Lethal limit, \*Tilapia.

The effect of different high temperatures (25 deg C) was studied on varying developmental stages of Tilapia nilotica L from Khartoum. The upper lethal temperatures and temperature tolerance were measured by holding the fish of different sizes and weights at different non lethal temperatures under similar conditions. Temperature resistance was less for both early larval and adult stages than for the fry stages. The median resistance time of larval stages was greater than that of adults. Median resistance time of the fry stage increased with an increased acclimation temperature up to 35 deg C Temperatures greater than 35 deg C caused a marked increase in the median resistance time of both larval and fry stages. The upper lethal tem-perature was highest for the fry stage. Sudden and large changes of high temperature did not affect T nilotica at any stage. (Affleck-Ariz) W69-00368

NUTRIENT AND ENERGY CYCLES IN AN ESTUARINE OYSTER AREA,

Dalhousie Univ, Halifax, Nova Scotia, Inst. of

Dalhousie Oliv, Transcriptor Oceanography. Fukuzo Uyeno. J Fish Res Bd Canada, Vol 23, No 11, pp 1635-1652, 1966. 23 p, 4 fig, 3 tab, 24 ref.

Descriptors: Chemical analysis, \*Cycling nutrients, \*Marine bacteria, Light, Molluscs, Oysters, Ecosystems, Energy budget, Phosphates, Water pollution sources, Nitrates, \*Primary productivity, Saline water, \*Estuaries, \*Eutrophication, Chlorophyli.

Identifiers: Energy cycles, Microbal content, Saline ponds, Prince Edward Island, Oyster area.

The nutrient circulation and microbial abundance of oyster-producing waters in the Malpeque Bay area, Prince Edward Island, were followed at 2 stations through an open season, and the efficiency of carbon assimilation and dissimilation was esti-mated. Part of the organic fall-out evidently en-tered the water again in the spring as nutrient salts, but a certain portion was not returned and this represented a net loss from the ecosystem. The nutrient circulation at a station located in a saltwater pond was more efficient than at a station located in a river estuary. At Levi Creek (Station A), high phosphate-P concentrations in September 1962 (2.10 microgram-atoms per liter) and in November (1,42 microgram-atoms per liter) might be derived from commercial fertilizer applied to cultivated fields. Occasional high values of nitrate-N were possibly due to particulate seston, and high mean values (about 4.8 microgram-atoms per liter) from July to the end of the season were attributed to rains. In the pond mineralization was 31% of primary production, largely by mud bacteria; in the estuary (Station C) it was 17%, due about equally to mud and water organisms. (Author) W69-00386

#### EARTH-SMELLING COMPOUND AS-SOCIATED WITH BLUE-GREEN ALGAE AND ACTINOMYCETES,

California Univ., Berkeley. For primary bibliographic entry see Field 05A. For abstract, see . W69-00387

THE LIMNOLOGICAL BEHAVIOR OF IRON IN NATURAL WATER,

Illinois State Water Survey, Peoria, Water Quality

Wun-Cheng Wang, and Ralph L. Evans. Presented at 156th Natl Meeting Amer Chem Soc, Atlantic City, N. J.

Descriptors: \*Iron, Adsorption, Turbidity, Lakes, Limnology, Colloids, Phosphate, \*Eutrophication, \*Water chemistry, Silica, Nutrients.

Identifiers: \*Particulate iron, Illinois, Peoria Lake, Freundlich isotherm, Langmuir isotherm.

A total of 9 sampling stations along 5 transects of Peoria Lake, Ill., were sampled at 1-2 week intervals from 13 March to 3 Oct 1967. Water samples were filtered through membrane filters and filters and filtrate separately analyzed for Fe (II) and total iron by standard phenanthroline method. Total iron ranged 0.69-13.01 mg/1 with a mean of 3.21. Greatest majority of the iron was present as Fe (III) (range: 0.52-7.36 mg/1; mean: 2.63). Combined particulate iron was 8-12 times greater than combined dissolved iron. Iron input is greater than output, so an increase of iron in the lake can be expected. The particulate Fe (III) in this lake has several characteristics: It can be correlated with water turbidity; the relationship between particulate Fe (III) and water turbidity does not follow the Freundlich or Langmuir adsorption isotherms; there is significant correlation between particulate Fe (III), particulate Fe (II), particulate silica, and particulate phosphate; the ratio of particulate Fe (III)/particulate Fe (II) is higher than the ratio of dissolved Fe (III)/dissolved Fe (II). These results suggest that iron may form complexes with particulate matter. The dissolved Fe (III) concentration is in excess of its solubility; it may exist in fine colloid or complex structure. (Author) W69-00388

INDUCED RAPID RELEASE AND UPTAKE OF PHOSPHATE BY MICROORGANISMS,

Minnesota Univ., Minneapolis, Limnological Research Center. Joseph Shapiro.

Science, Vol 155, No 37.67, pp 1269-1271, 10 Mar 1967. 3 p, 3 fig, 1 tab, 10 ref.

Descriptors: \*Phosphates, Cycling nutrients, Bioindicators, Bacteria, \*Microorganisms, Eutrophica-tion, Protozoa, Cultures, \*Activated sludge, Microbiology, Sludge treatment, Sphaerotilus, Escherichia, Bacillus sereus, Flavobacterium, Vorticella, Opercularia, Epistylis, E. coli. Identifiers: Esherichia, Bacillus cereus, Flavobac-

Mixed cultures of sludge organism including bacteria (e.g., Zooglea remigera, Escherichia inter-medium, Bacillus cereus, Flavobacterium), filimenmedium, Bacillus cereus, Flavobacterium, filmentous organisms (Sphaerotilus natans), and protozoa (e.g., Vorticella, Opercularia, Epistylis) are able to release actively a large proportion of their phosphorus (P) to the medium in a matter of hours when kept under anoxic conditions. At 30 deg C phosphate-P rises from an initial value of 4 to 70 mg/1 in 3.5 hr and as much as 40% of total phosphorus originally present in the culture is released. The process, which is completely reversible upon aeration, has a change in rate (for a change of 10 deg C) of 2 to 2.5. Uptake after reaeration is inhibited by metabolic inhibitors (dinitrophenol, mercuris chloride). The amount of phosphate released per unit of sludge remains constant for concentrations ranging from 1700 to 15,800 mg sludge/1, and higher concentrations of phosphate in solution do not inhibit release. P is lost, probably as orthophosphate principally from the acid-soluble fraction of the cells. Experiments with dense cultures of E coli showed similar results. (Eichhorn-Wisc) W69-00389

## 5D. Waste Treatment **Processes**

MACARTOR V GRAYLAND CREST III SWIM CLUB, INC. (REASONABLE USE TEST-PER-COLATING WATER).

187 A 2d 417-421 (Del 1963).

Descriptors: \*Water law, \*Percolating water, \*Delaware, Judicial decisions, \*Reasonable use, Wells, Remedies, Water rights, Damages.

The case involves a suit to enjoin the defendant swim club from, inter alia, using a deep well on its property to the detriment of the plaintiffs' shallow well. The court first stated that in allocating rights in percolating water, an 'objective' reasonable use test would be employed. Factors favoring the adoption of this rule are given. After a careful weighing of the equities on both sides of the case, the Chancellor granted the plaintiffs' request for an injunction on the condition that plaintiffs deepen, or allow defendant to deepen plaintiff's well to a reasonable depth with the cost to be equally divided. An alternative remedy proposed by the court is that plaintiffs run, at their own expense, a line to the defendant's public water supply, plaintiffs to thereafter pay a proportion of the costs of the public water attributable to their use. (Patterson-Fla) W69-00036

TREATMENT **USING** TERTIARY DIATOMACEOUS EARTH AND ACTIVATED CARBON,

Wayne State University, Dept. Civil Engineering,

Detroit, Michigan.
Henry A. Dirasian.
Pap from OWRR project No A-021-Mich, Wayne
State Univ, 1968. 17 p, 4 tab, 6 fig, 9 ref.

Descriptors: \*Tertiary treatment, \*Activated carbon, \*Filtration, \*Fly ash, \*Diatomaceous earth, Suspended load, Chemical oxygen demand, Biochemical oxygen demand, Organic matter.
Identifiers: \*Fly ash filters, \*Diatomaceous earth

A study was made of the effectiveness, but not the A study was made of the effectiveness, but not the economic feasibility, of tertiary treatment of sewage by diatomaceous earth, activated carbon, and fly-ash filtration. The best results, 98.4% removal of SS and 88% of COD, were obtained using diatomaceous earth with some activated carbon. Fly ash did not work as well, but it appears desirable because of low cost. A properly graded, washed fly ash filter might yield BOD and SS removals as high as 80-90% or more. (Knapp W69-00109

terium, Vorticalla, Opercularia, Epistylis.

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 05

### Ultimate Disposal of Wastes—Group 5E

VATER REUSE--WHAT DO WE MEAN.

George E. Symons. Water and Waste Eng, Vol 5, No 6, pp 40-43, June 968. 4 p, 4 fig, 1 tab, no ref.

Descriptors: \*Water reuse, Artificial recharge, Irigation water, Sewage treatment, Hydrologic cy-le, Rivers, Water pollution, Water pollution treat-

nent, Kansas. dentifiers: \*Reclamation (Waste water), Neosho tiver, Chanute, Kansas.

Vater reuse is defined and discussed with particuar attention to the various meanings to water users, he categories of reuse, and the current and future tatus of the processes involved. Reuse is defined as he use of treated or partially treated wastewater or any purpose that requires water free or substanally free of pollutants. Reuse may be accomlished through the hydrological cycle, the natural ycle, the indirect cycle, and the direct cycle. here is no control over the hydrological cycle. All rater not undergoing any artificial process is in it. he natural cycle involves unplanned sequential se of water by communities in the direction of atural flow, and is very common on all populated iver systems. The indirect cycle is the planned eturn of treated wastewater to the natural cycle, ither to streams or groundwater recharge. The irect cycle is the planned treatment of wastewater or a specific immediate reuse. Direct-cycle reuse is common industrial process, but has been used in nunicipal supplies only for emergency purposes. ndirect reuse of municipal water is increasing apidly and is important for control of river polluon and for replenishing groundwater supplies. (Kapp-USGS) V69-00110

ACTORS IN NEUTRALIZING ACID MINE VATERS WITH LIMESTONE, bureau of Mines, Dept. of the Interior, Pittsburgh lining Research Center.

L. A. Mihok, and C. E. Chamberlain.

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 265-273, May 1968. 9 p, 9 fig,

Descriptors: \*Acid mine water, \*Pollution abatement, \*Waste water treatment, \*Neutralization, Calcium carbonate, Iron oxide, Acidity. dentifiers: Iron removal.

continuous limestone neutralization pilot plant apable of handling 100 gpm of acid-iron water was esigned, constructed, and operated to study some f the factors controlling neutralization and oxidaon processes. Rapid neutralization of acid water was achieved with the use of coarse crushed mestone in a rotary-kiln-type reactor. Subsequent eration of neutralized water from the reactor emoves soluble ferrous iron at the rate of 1 to 4 pm per minute. Ferrous iron removal during eutralization and aeration is dependent on pH and emperature. In the limestone reactor, at normal the indistribution of the indistribution of the indistribution in water temperatures, soluble iron is removed to a rate of 30 to 35 ppm per minute. Although the H of the neutralized waters ranged from 6.5 to .5, sufficient alkaline activity was not achieved to ring about mass precipitation of insoluble ferrous ydroxide, despite an excess of finely divided mestone remaining in suspension. The presence of n abnormally high concentration of CO2 in the atnosphere (about 0.16 percent) at the reactor site nay cause pH suppression. (Knapp-USGS) W69-00133

ERTIARY TREATMENT **USING** DIATOMACEOUS EARTH AND ACTIVATED CARBON,
Vayne State University, Detroit, Mich.

June 1968, 18 p, 6 jg, 4 tab, 9 ref.

pollution Descriptors: Water pollution control, Diatomaceous earth, \*Activated carbon, Fly ash, iltration.

A study was conducted to determine the feasibility of treating secondary treatment plant effluents in a filter aid pressure type filter using diatomaceous earth as the filtering media while varying concentrations of activated carbon were added to enhance removals through adsorption; it was carried out in three phases. First, diatomaceous earth alone was used as filtering media. Next, activated carbon was added to diatomaceous earth, and finally, investigations were made using surplus fly ash as filtering media. Secondary waste treatment plant effluents can be further treated by this method and additional organic matter removed. Using diatomaceous earth alone about 65% of the BOD was removed and about 93% in suspended solids. Using diatomaceous earth and activated carbon removals as high as 88% of BOD and 98% of suspended solids were attained. This type of treatment indicated improvement in the quality of effluents discharged to the stream. Emphasis should be placed on removals using fly ash as the filtering media. It was felt that fly ash could do an acceptable job. Some consideration would have to be given to grading and washing of fly ash before use. It is recommended that further studies be conducted on fly ash filters. W69-00223

#### FACTORS IN THE DESIGN OF AN ACID MINE DRAINAGE TREATMENT PLANT,

West Virginia Univ., Morgantown, School of

Charles T. Holland, James L. Corsaro, and Douglas

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 274-290, May 1968. 12 tab, 6

Descriptors: \*Acid mine water, \*Pollution abatement, \*Pilot plants, \*Cost analysis, \*Waste water treatment, Iron oxides, Sulfate, Acidity, Lime, West Virginia.

Identifiers: \*Acid mine water treatment plants, \*State Water Board requirements.

A pilot plant was designed, built and operated to estimate the cost of treating acid mine drainage to meet standards of the West Virginia State Water Board. Factors investigated in the treatment of acid mine drainage are introduction of the feed water to the plant, neutralization, oxidation, sludge settling, sludge handling and disposal, land requirements, and costs. A flow sheet illustrates plant layout and the stage at which various operations are carried out. Operating expenses of a plant designed to treat 8,100,000 gpd of highly acid mine water are estimated to be 47.75 cents per 1,000 gallons, and for weakly acid water, 18.90 cents per 1,000 gallons. (Knapp-USGS) W69-00234

# REMOVAL OF IRON FROM ACID MINE WITH THE AID OF HIGH ENERGY RADIATION, PART III,

Brookhaven National Laboratory, Upton, New

M. Steinberg, J. Pruzansky, and L. R. Jefferson. Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 308-318, May 1968. 11 p, 4 tab, 4 ref.

Descriptors: \*Acid mine water, \*Pollution abatement, \*Waste water treatment, \*Aeration, \*Irradiation, Cobalt radioisotopes, Calcium carbonate, Iron oxides, Acidity, Limestones. Identifiers: \*Iron removal, Fulton Borehole acid mine drainage.

Experimental data are presented on the rate of oxidation and removal of ferrous iron from Fulton Borehole acid mine drainage, a high iron (350 ppm) acid water (pH-3.1) by mechanical agitation and aeration with a large excess of crushed limestone and with the effect of radiation. It ap-pears that up to 83.5 ppm/min of Fe removal can be obtained with limestone neutralization alone at a pH less than 6.5 at a temperature of 10 deg C Particle size, degree of agitation, and mass ratio of limestone to mine water appear to be important variables in obtaining high removal and neutralization rates. Whereas Co-60 gamma radiation can yield high rates and high chain G values for Fe removal in the absence of vigorous agitation, the incremental contribution of radiation decreases as the rate of neutralization by limestone increases. It would be difficult to justify a radiation process in view of the rate of iron removal that has already been observed with limestone neutralization. Based on this study and studies of the U S Bureau of Mines it is suggested that an engineering development program be undertaken for treating Fulton Borehole drainage with field limestone. (Knapp-W69-00237

# SUMMARY OF SELECTED LITERATURE ON LAGOON AND SPRAY SYSTEMS OF TREATING FRUIT AND VEGETABLE PROCESSING WASTES

Clemson Univ., Clemson, South Carolina. G. H. Liner, and J. M. Stepp. Dep of Agr Econ and Rural Sociol, S C Agr Exp Sta, Clemson Univ, 26 p, July 1968. 40 ref.

Descriptors: \*Waste treatment, \*Lagoons, \*Sprinkler irrigation, \*Reviews, \*Bibliographies, Aerobic treatment, Waste water disposal. Identifiers: Fruit and vegetable processing wastes.

The literature of the treatment in lagoons or disposal by irrigation spraying of wastes from fruit and vegetable processing plants is reviewed and a comprehensive bibliography is compiled. Characteristics of cannery wastes, technology of disposal, and costs of treatment are not discussed. Nationally, 62% of processing wastes are handled by municipal facilities and 38% are disposed of by means which ordinarily do not involve treatment. Fruit and vegetable processing are highly seasonal and often plants can not afford proper treatment facilities for discharge into streams; the use of lagoons and disposal of waste by irrigation spraying is discussed as an acceptable economical alternative. (Knapp-USGS)
W69-00258

#### THE LEGISLATIVE APPROACH TO AIR AND WATER QUALITY.

For primary bibliographic entry see Field 06E. For abstract, see . W69-00330

#### RISK EVALUATION IN SEWAGE TREATMENT PLANT DESIGN,

Cornell Univ, Ithaca, NY. For primary bibliographic entry see Field 06A. For abstract, see . W69-00354

## A LEAST COST EVALUATION OF DISPOSAL SYSTEMS FOR LOW LI RADIOACTIVE WASTES, Harvard Univ., Cambridge, Mass. LEVEL LIQUID

For primary bibliographic entry see Field 06A. For abstract, see. W69-00356

## 5E. Ultimate Disposal of Wastes

### CHARACTERISTICS OF INTERFACE FLOW IN SUBSURFACE DISPOSAL SYSTEMS,

Michigan Technological Univ., Houghton. Carl O. Gast. OWRR Report A-019-Mich., A Master's Thesis by the author, 1968, 126 pp. 39 fig, 3 tab, 16 ref, 2 Ap-

Descriptors: \*Septic tanks, \*Soil disposal fields, Earth water interfaces, Soil water movement, Porosity, Sewage disposal.

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5E—Ultimate Disposal of Wastes

A section of a septic tank drain field was constructed and tested under conditions simulating the conventional and the dosing chamber. Distribution of effluent along the length of the trench soil interface was studied. The effect of physical clogging, using bentonite as a clogging agent, also was investigated. The test section consisted of a 2' x 2' x 24' long box containing a standard trench placed in graded sand. Discharges from this section were measured at one foot intervals along the length of the section. Piezometer readings gave the depth of water at one foot intervals along the trench. Conclusions were: (1) For the conventional system using standard products for the distributor, the effluent was distributed over at most 7 feet of the trench. (2) For dosing chamber tests using dose volumes recommended by P.H.S., a distinct unbalance in the distribution resulted. (3) Uniform distribution could be obtained using a dose volume of approximately 200% of the inside volume of the distributor. (4) Physical clogging tests showed the conventional system outlasting the dosing system by approximately 30%. This condition was proven mathematically and logically. (5) A level trench bottom would provide for maximum utilization of the field regardless of flow type or slope of distributor pipe. (Santeford-Mich Tech) W69-00217

# 5F. Water Treatment and **Quality Alteration**

AN INVESTIGATION OF ALTERNATIVE MEANS OF ACHIEVING WATER QUALITY OBJECTIVES,

Oregon State Univ, Corvallis. For primary bibliographic entry see Field 06A. For abstract, see . W69-00346

SENSITIVITY ANALYSIS OF ACTIVATED

SLUDGE ECONOMICS, Stanford Univ, Stanford, Calif. For primary bibliographic entry see Field 06C. For abstract, see . W69-00352

## 5G. Water Quality Control

SANITARY WATER BD V MUNICIPAL AUTH (ADMINISTRATIVE POLLUTION ABATEMENT).

State of Pennsylvania, Harrisburg

79 Dauph 316-323 (Pa Com Pl 1962).

Descriptors: \*Pennsylvania, Judical decisions, \*Administrative decisions, Administrative agencies, Water pollution control, Water quality control, \*Pollution abatement, Water law, Water permits.

Identifiers: \*Water Sanitary Board.

The case involves an appeal from an order of the Pennsylvania Water Sanitary Board ordering the New Oxford Municipal Authority to discontinue the discharge of treated sewage effluent into an unnamed tributary and to construct an outfall sewer elsewhere. Under section 207 of the Pennsylvania Clean Streams Law of 1937, P S 691.207, plans for new sewer systems and extensions of old ones must be submitted to and approved by the Board. Constructions nut approved or maintained in accordance with the rules and regulations of the board, are declared to be an abatable nuisance. Pollution, as defined by the statute, may also be abated by the Board. The court in the instant case rejected the Authority's challenge to the Board's order that the evidence upon which the Board based its findings and conclusions was insufficient. (Patterson-Fla) W69-00013

INFLUENCE OF TIME AND PRECIPITATION ON CHEMICAL COMPOSITION OF SPOIL DRAINAGE.

Ohio Agricultural Research and Development Center, Wooster, and U. S. Corps of Engineers, Cincinnati.

J. P. Vimmerstedt, and P. H. Struthers.

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 152-163, May 1968. 12 p, 1 tab, 11 fig, 4 ref.

Descriptors: \*Acid mine water, \*Leaching, \*Lysimeters, \*Spoil banks, \*Acidic soils, Strip mines, Model studies, Weathering, Rainfall, Sulfates, Ohio.

Identifiers: Experimental soil leaching, Leachate, Spoil drainage.

An experimental strip mine spoil-leaching study to identify and measure the chemical products of spoil weathering was initiated 9 years ago in Ohio. Coal mine spoil is leached in 1 foot diameter lysimeter tubes, 4 feet deep, under natural climatic conditions. Each year's leachate is collected and analyzed for concentrations of total soluble salts, sulfate, calcium, magnesium, iron, aluminum, and manganese. The spoil sources were assigned to 4 general classes: toxic, with a pH less than 4.0 on over 75% of the outcrop area; acid, with pH of 5.0-6.9 on 50% of the area; marginal, with pH below 4.0 on 50-75% of the area; and calcareous, with pH over 7.0 on over 50% of the area. The amount of leachate and the weight of salts leached followed the same general trend as rainfall, but the total amounts of pyrite oxidation and weathering of other minerals per unit precipitation decreased with time. Toxic and marginal spoils yielded about 100 times more Fe, Al, and Mn, and 5 times more total salts than calcareous and acid spoils. Where toxic and marginal spoils are exposed, their high potential for acid and salt production must be recognized and extra care should be taken to minimize erosion and runoff and maximize infiltration. (Knapp-USGS) W69-00092

AN EVALUATION OF FACTORS AFFECTING ACID MINE DRAINAGE PRODUCTION AND THE GROUND WATER INTERACTIONS IN SELECTED AREAS OF WESTERN PENNSYLVANIA,

Pennsylvania State University, Department of Geology and Geophysics, University Park. Frank T. Caruccio.

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 107-151, May 1968. 45 p, 11 tab, 13 fig, 22 ref.

Descriptors: \*Acid mine water, \*Acid bacteria, \*Environmental effects, \*Hydrogen ion concentration, \*Calcite, Inhibition, Water quality, Groundwater, Pennsylvania.

Identifiers: Calcite-pyrite intergrowths, Acid potential, Alkaline waters.

A laboratory and field study was undertaken to find the differences between acid and non-acid strip mines, to determine the acid potential of rocks with varying sulfur content, and to correlate various factors in acid drainage, including regional water quality, regional rock type, and interactions between acid mine drainage and natural waters. Strip mines in the Clearfield area, which are underlain by acid-producing 'marine-brackish' Lower and Middle Kittaning Formations, and in the Glen Richey area underlain by non-acid-producing 'fresh-water' Freeport strata were studied. The most critical factor in acid water production is the presence of calcium carbonate; alkaline waters will abate the acidity. Bacteria catalyze pyrite oxidation, but grow only in a limited low pH range; alkaline waters sterilize the environment. Once bacteria contaminate a mine, they can produce enough acid to overcome carbonate inhibition. Bacterial generation of acid mine waters is self propagating. The difference in acid production in the 2 studied is possibly that pyrite in the Glen Richie area contains enough admixed calcium carbonate to prevent acid bacteria; whereas pyrite in the Clearfield area does not. (Knapp-USGS) W69-00095

REDUCTION OF ACID PRODUCTION IN COAL MINES WITH USE OF VIABLE ANTI-BACTERIAL AGENTS, MSA Research Corp., Division of Mine Safety Ap-

pliances Company, Evans City, Pa. R. E. Shearer, W. A. Everson, and J. W.

Mausteller.

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 98-106, May 1968. 9 p, 5 fig, no ref.

Descriptors: \*Acid bacteria, \*Acid mine water, \*Inhibitors, \*Biocontrol, \*Bacteriophage, Bactericides.

Identifiers: Parasitic bacteria, Caulobacter, Antibiotics (Bacterial).

Laboratory studies involving passage of water through piles of coal show that bacterial acid production can be reduced by factors as high as 30 with 3 inoculations in 6 months of natural anti-bacterial agent found in some non-acidic mines. Concentrated anti-bacterial cultures were developed on solid media; similar techniques might be used in liquid media to produce large quantities of culture of mine dosing. The nature of the anti-bacterial agent is unknown. No phages were seen with the election microscope, but washing with distilled water in sampling may have destroyed them. The inhibitor may be a competition effect from Caulobacter, which was observed in inhibited cultures and may have either obstructed the access of acid bacteria to their nutrient or acted as a parasite. Antibiotics produced by other organisms may be involved. (Knapp-USGS) W69-00097

AN EXPERIMENTAL STUDY OF FERROUS IRON IXIDATION IN ACID MINE WATER, U. S. Bureau of Mines, Pittsburgh Mining Research

Center, Pittsburgh, Pa.

Ann G. Kim.

Reprints of Pap 2d Symp on Coal Mine Drainage
Res, Mellon Inst, pp 40-45, 1968. 6 p, 3 fig, 2 ref.

Descriptors: \*Acid mine water, \*Waste water treatment, \*Oxidation, \*Iron, \*Aeration, Chemical oxygen demand, Iron bacteria, Sulfides, Sulfates. Identifiers: Ferrous iron oxidation.

Samples of natural mine water were studied to determine the effect of aeration upon the rate of oxidation. The rate of oxidation of ferrous iron in an acid environment depends upon the concentrations of ferrous iron and dissolved oxygen, and upon the temperature. Eight 1-liter samples were used for each test. Four samples were aerated at rates of 200 cubic centimeters per liter per minute and 2,000 cubic centimeters per liter per minute; 2 were in open containers to allow normal oxygen diffusion from the air into the water and 2 were in closed containers with dissolved oxygen originally present in the water. Aeration was found to have no beneficial effect upon a low ferrous iron water (34 ppm) because the water had an adequate amount of dissolved oxygen. It did decrease the time necessary for complete oxidation in waters with 175 to 260 ppm ferrous iron, evidently by keeping the water saturated with dissolved oxygen. (Knapp USGS) W69-00099

INVESTIGATION PROGRAM FOR AQUIFER PROTECTION REQUIREMENTS, CHICAGO-LAND DEEP TUNNEL PLAN,

Harza Engineering Company, Water Resources Planning Division, Chicago, Ill. I. S. Papadopulos, and R. E. Aten.

Ground Water, Vol 6, No 3, pp 4-9, May-June 1968. 6 p, 2 fig, 3 ref.

Descriptors: \*Sewage disposal, \*Runoff, \*Tunnels, Injection wells, Model studies, Permeability, Ilinois, Rainfall intensity, Aquifers, Water quality, Water storage, Groundwater, Analog models, bewers, Exploration.
dentifiers: \*Aquifer protection, \*Chicago, Pump-

ng tests, Injection tests.

A study is described of requirements for aquifer protection in connection with Chicago's Deep Tunel Plan for Flood and Pollution Control being implemented by the Metropolitan Sanitary District. Plans call for temporary storage of combined sewer overflows in a system of tunnels about 800 ft below he city. The same sewer system is used for mu-nicipal waste and surface drainage. When rainfall ntensity is over 0.1 in. per hr, the system now overlows and raw sewage enters streams. Proposed nows and raw sewage enters streams. Proposed controls include separate sewer systems, concentric sewer-pipe systems, shallow holding tunnels, and the deep tunnel plan, which is considered the most and most economical. Favorable tunnel locations ion is in the Galena-Platteville dolomite, which contains the aquifer that must be protected from contamination. Electric analog studies using availaele data show that protection can be provided by operating recharge wells so as to maintain continuous flow into the tunnels. Recent studies include letailed exploratory drilling, aquifer test, pumping ests in the zone to be tunneled, injection tests, and an analog model analysis for showing future effects of the tunnels and recharge operations. (Knapp-

W69-00106

MINE AIR SEALING: A PROGRESS REPORT,

Bureau of Mines, Dept. of the Interior, Pittsburgh Mining Research Center. Noel N. Moebs.

Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 255-264, May 1968. 10 p, 8

Descriptors: \*Acid mine water, \*Mine drainage, Pollution abatement, \*Model studies, \*Research and development, Coal mines, Pennsylvania. dentifiers: \*Coal mine sealing, Air sealing, Upper

Freeport coalbed.

A small, abandoned above drainage coal mine in he Upper Freeport coalbed in western Pennsylvania, which discharges acid water, was air sealed n 1966 to determine if the acidity and iron of the discharge could be reduced. The geologic and nydrologic environment of the mine were investigated to aid in evaluating the effectiveness of ir sealing and indicate the controlling factors. Ground water level, quality, and composition of the overburden were obtained from drill holes. The atnosphere in the sealed mine was sampled periodically, and the differential air pressure across the cal was recorded. The flow rate fluctuates between 6 and 632 gpm. About 30 percent of the otal annual precipitation over the 77-acre area percolates downward into the mine. The water able over most of the mined area has been depressed as a result of mining, and some springs and wells on the property were lost during mining. Water pH remained between 3.0 and 3.5 for the duration of the experiment, and total iron decreased slightly, as has the total acidity. For the first 19 months after sealing there was no significant improvement in the quality of the mine efluent which could be attributed to sealing, other than a decrease in variance. (Knapp-USGS)

SOME CHARACTERISTICS OF DRAINAGE FROM DEEP BITUMINOUS MINES IN WESTERN PENNSYLVANIA, Pennsylvania Department of Health, Harrisburg,

W69-00116

Penisylvania Div. of San. Eng. Grover H. Emrich, and D. R. Thompson. Reprints of Pap 2d Symp on Coal Mine Drainage Res, Mellon Inst, pp 190-222, May 1968. 33 p, 52

Descriptors: \*Mine drainage, \*Coal mines, \*Bituminous materials, \*Acid mine water, \*Water quality, Acidity, Alkalinity, Water quality control, Standards, Pennsylvania.

Identifiers: Bituminous coal mine drainage.

Data on quality and quantity of deep bituminous coal mine drainage water (in western Pennsylvania) are compiled and presented on maps. The quality data are mapped in simplified form and per-centages of mines with acid water are compiled for each county. Numbers of mines with acid, alkaline, and no discharge are also given by county. In general, the younger coal seams (Sewickley-Pittsburgh) have more alkaline discharges and the older seams (Clarion-Brookville) have discharges. Several seams vary regionally in discharge quality. Sewickley and Pittsburgh are alkaline in the southwest counties because of the presence of larger, proportions of limestone, and more acid north and east where there is less limestone. There is a low-acidity band in Clearfield, Armstrong, and Indiana counties in the Lower Freeport Seam; to the northwest and southeast, discharges are acid. (Knapp-USGS)

# MIGRATION OF BACTERIOPHAGE T4 IN PERCOLATING WATER THROUGH SELECTED OAHU SOILS,

Hawaii Univ., Honolulu. Richard M. Tanimoto, Reginald H. F. Young, and Nathan C. Burbank, Jr.

OWRR Project No. A-001-HI, Water Resources Research Ctr, Tech Rpt No 20, Jun 1968. 45 p, 9 fig, 4 tab, 64 ref.

Descriptors: \*Viruses, \*Bacteriophage, Percolation, Ground-water, Water pollution.

Tests to determine the ability of three Oahu soils to remove the coliphage T4Br11 mutant virus from water percolating through low humic latosols (Wahiawa and Lahaina soils) proved the soils ability to retain the virus but only at depths greater than 21/2 inches. Absorption was 100% when the concentration applied was 2.5 x 10 to the 6 power virus per ml of feed solution. Breakthrough at lesser thicknesses of soil occurred slowly at first then increased rapidly with time. Tantalus tuff, a cindery pumice substratum was ineffective in retaining viruses even at soil thicknesses of as great as 15 inches. (Burback-Hawaii) W69-00225

#### EXCESS BENEFIT,

Virginia Univ, Charlottesville. For primary bibliographic entry see Field 06B. For abstract, see . W69-00228

#### NEW JERSEY WATER PROBLEMS AND PLANNING,

American Water Works Assoc, New York.

R. J. Hughes. J Amer Water Works Assoc, Vol 59, No 4, pp 1209-1212, Oct 1967. 4 p.

Descriptors: \*New Jersey, Water pollution, Air pollution, Pollution abatement, Sewage treatment, Delaware River Basin Commission, River systems, River basin development, Planning, Project planning, Legislation, State governments, Political spects, Education.

Identifiers: Regional approach (Planning).

In an address to the American Water Works Association's annual conference, Governor Hughes of sociation's annual conference, Governor Hughes of New Jersey, gives a broad overview of New Jersey's water problems and its projects in the area. He covers the need for water in the northeast portion of the state, water pollution and control, sewerage facility planning, the establishment of a Clean Water Council, and the regional approach to solving water problems through the Delaware River Basin Commission. W69-00282

33

GUIDELINES FOR ESTABLISHING WATER QUALITY STANDARDS FOR INTERSTATE WATERS

Federal Water Pollution Control Admin., Washington, D. C.

Guidelines for Establishing Water Quality Standards for Interstate Waters, pp 1-10, Jan 1967. 10

Descriptors: \*Pollution abatement, \*Water policy, \*Water Quality Act, \*Administration, Water law, Administrative decisions, Federal government, State governments, Watercourses (Legal), Interstate, Interstate rivers.

Identifiers: Water Pollution Control Act, \*Interstate waters, Department of the Interior.

The Federal Water Pollution Control Act, as amended by the Water Quality Act of 1965, provides for the establishment of water quality standards for interstate waters. Unless a state adopts water quality criteria and plans for implementing them, and they are approved by the Secretary of the Interior, the Secretary is authorized to establish them. This paper purports to present guidelines for developing water quality criteria and plans for implementing and enforcing them, and to delineate factors which the Secretary will consider in approving a state's actions in this matter. The primary guidelines are found in the Federal Water Pollution Control Act, the Water Quality Act of 1965, and legislative history. Conservation values must be considered under this legislation. A cornerstone of the policy guidelines, which are set forth in considerable detail, is that no one has the right to pollute. Discharge of untreated wastes into interstate streams should be eliminated under a State's plans. The term 'interstate waters', which defines the coverage of legislation behind the standards, is amplified. Means of obtaining cooperative assistance from the Federal Water Pollution Control Administration are outlined. W69-00284

THE ECONOMICS OF REGIONAL WATER QUALITY MANAGEMENT: WATER POLLU-TION AND RESOURCES ALLOCATION BY PRIVATE MARKETS, Allen V. Kneese.

Baltimore, Johns Hopkins Press, 1964. p. 38-53.

Descriptors: \*Water allocation (Policy), \*Water pollution control, \*Economic efficiency, \*Damages, Costs, Cost sharing, Administration, Decision making, Diseconomies of scale, Water pollution effects, Water pollution treatment, Water rights, Remedies, Upstream, Downstream, Water users, Water shortage, Water law, Technology.

Most economists consider the market system as an efficient device for allocating resources pursuant to consumer wants. Water pollution is a classic example of technological external diseconomy. One key to the pollution problem is the failure of municipal and industrial waste dischargers to consider that subsequent water uses may be made more expensive or foreclosed entirely by the discharge. The results are higher costs of treatment and increasing wastes. There is a close relation between the nature of property rights and the occurence of external diseconomies. Property rights should be structured such that upstream polluters will take into account downstream costs. Legal remedies are inadequate in several respects. The possibility of internalizing the externalities into a private decision making unit over an entire basin is discussed. The relationship of upstream discharges and downstream damages is also discussed. Downstream costs must be measured against upstream depletion reduction. Consideration of water shortages involve the same principles. The market place and judicial system do not automatically result in realization of downstream damages. W69-00286

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G—Water Quality Control

THE ECONOMICS OF REGIONAL WATER QUALITY MANAGEMENT: NATURE OF THE PROBLEM,

Allen V. Kneese

Baltimore, Johns Hopkins Press, 1964. p 3-34.

Descriptors: \*Water quality, \*Water pollution, \*Pollutants, \*Water pollution treatment, Water quality control, Institutions (Planning and orquanty control, institutions (Planning and organizational agencies), Pollutant identification, Biochemical oxygen demand, Technology, Water pollution effects, Waste dilution, Artificial recharge, Recirculated water, Desalination, Regulated flow

Despite the great interest in the problem of water quality and recent pollution control efforts, serious problems still exist and action by economists and public administrators is needed. Water quality management raises questions as to the determination of water quality, the systems to achieve that quality, and the institutions to administer that quality. Pollutants can be categorized as degradable and nondegradable. The measurement of degradable organic wastes and the rate of waste degradation presents technical problems. One measure is biochemical oxygen demand, BOD. Automatic monitoring is becoming more widespread. There is less certainty in the water environment field than most other scientific fields. Water quality may be improved by treating wastes or by increasing dilution. Methods of treating waste water are described. Water supply treatment is similar in nature. Other treatment subjects include direct recirculation, desalinization, divided distribution systems, and artificial recharge. Dilution of wastes may be accomplished by alteration of either the pattern of streamflow or waste discharge. This section concludes with considerations of economic factors and administrative decision-making processes. W69-00287

#### WATER SUPPLY AND POLLUTION CONTROL ASPECTS OF URBANIZATION,

Duke Univ., Durham, N. C., School of Law For primary bibliographic entry see Field 04C. For abstract, see. W69-00290

#### FEDERAL AIR AND WATER CONTROL: THE APPLICATION OF THE COMMERCE POWER. George Washington Univ., Washington, D. C. Sidney Edelman.

George Washington L Rev, Vol 33, No 5, pp 1067-1087, June 1965. 21p, 122 ref.

Descriptors: \*Air pollution, Impaired water quality, Public health, \*Water pollution, Pollution abatement, \*Water pollution control, Control, Federal government, Interstate, Water law, Clean Air Act, \*Federal jurisdiction, Judicial decisions, Water rights, Legislation, Jurisdiction, State governments, Legal aspects, Navigable waters. Identifiers: Constitutional law.

The federal commerce power is analyzed on the basis of its application to air and water pollution. Federal statutes designed to allow the Attorney General to bring court actions to secure abatement of both interstate and intrastate pollution are discussed. The constitutional basis for the exercise of such power is given primary emphasis. The issue is not difficult when pollution is interstate. Control fits clearly within the confines of the commerce power. When intrastate water pollution takes place in a navigable stream, the basis of federal control is considered similarly clear. Federal jurisdiction over intrastate air pollution rests on the fact that such pollution affects interstate commerce, or obstructs the navigable air space. It is concluded that the same principles which serve as a basis for congressional authority to protect navigable waters as highways of interstate commerce are applicable to navigable air space. W69-00291

NOR ANY DROP TO DRINK: PUBLIC REGU-LATION OF WATER QUALITY PART I: STATE POLLUTION CONTROL PROGRAMS,

U of Iowa College of Law, Iowa City, Iowa For primary bibliographic entry see Field 06E. For abstract, see W69-00335

# WATER POLLUTION - ATTEMPTS TO DECONTAMINATE FLORIDA LAW,

U of Florida, Gainesville, Florida. For primary bibliographic entry see Field 06E For abstract, see . W69-00336

# INDUCED RAPID RELEASE AND UPTAKE OF PHOSPHATE BY MICROORGANISMS,

Minnesota Univ., Minneapolis, Limnological Research Center.

For primary bibliographic entry see Field 05C. For abstract, see . W69-00389

# MINE WATER RESEARCH: THE LIMESTONE NEUTRALIZATION PROCESS, Bureau of Mines, Department of the Interior, Pitt-

sburgh, Pa.

E. A. Mihok, Maurice Deul, C. E. Chamberiain, and J. G. Selmeczi.

U. S. Bureau of Mines Report of Investigations 7191, September 1968, 20 p, 14 fig, 7 tab, 3 dwg, 6 photo, 3 chart, 6 ref.

Descriptors: \*Neutralization, \*Limestones, \*Acid mine water, \*Water pollution treatment, Acidity, Alkalinity, Carbon dioxide, Chemical precipitation, Aeration, Oxidation, Sedimentation, Slurries, \*Particle size, Water chemistry, Carbonates, Acidic waters, Autogenous grinding.

Identifiers: Stream improvement, Pollutants, Water quality, Reclaimed water, Mine water.

A pilot plant for treating mine drainage by neutralization with limestone was designed, fabricated, and operated. The process produces a very fine (minus 400-mesh) limestone slurry in a tube mill, mixes the slurry with mine water, aerates mixture to remove carbon dioxide and precipitate iron, and separates solids from the liquid by sedi-mentation. Water of pH 2.8, 1,700 ppm total acidity, 36 ppm ferrous iron, and 360 ppm iron, was treated at rates of 300 to 400 gpm and ultimately reached a pH of 7.4 and contained no detectable iron. The sludge compacted to one-third the volume from mine water neutralized with lime. The advantages of the limestone process are wide distribution and low cost of limestone, simplicity, reduction of hazards and of operating and maintenance costs by use of a less reactive agent, higher tenance costs by use of a less reactive agent, nigner solids concentration in the sludge, and no deleterious effect caused by overtreatment. Cost of treating mine water by the limestone process is at least one-third to one-half the cost of the lime process. (Mihok-Bur Mines) W69-00397

### 06. WATER RESOURCES **PLANNING**

## 6A. Techniques **OF Planning**

#### OPTIMIZATION METHODS IN WATER RESOURCES PLANNING,

Missouri Univ., Columbia, Department of Agricultural Economics.

Oscar R. Burt. Florida Univ, Institute of Food and Agr Sci, Water Research Needs: An Economic Appraisal, Pub No 3, pp 75-85, Dec 1967. 11 pp, 17 ref.

Descriptors: \*Linear programming, \*Dynamic programming, \*Systems analysis, Water resources development.

Identifiers: Economics, \*Mathematical studies, Planning

Three optimization techniques were discussed, mathematical (linear) programming, dynamic programming, and simulation. Mathematical programming is comprised of an objective function of several variables which is maximized subject to a set of constraints on the variables. The mathematics of dynamic programming permit estimation of conditional decision rules or strategies that optimize an expected value criterion function. The only requirement is that the dependence relationship of the process be markovian from stage to stage (time period to time period). Simulation is used as a device to calculate an observation on the objective function for given magnitudes of certain decision variables. Given the decision variables, the objective function is a random variable whose probability distribution is specified in the simulation model. The ultimate objective of the research is to explore the mean of the objection function as it is related to the decision variables. The applicability of the three optimizing techniques to water resource problems was also discussed. (Grossman-Rutgers) W69-00169

# WHEN IS IT SAFE TO EXTEND A PREDIC-TION EQUATION - AN ANSWER BASED UPON FACTOR AND DISCRIMINANT FUNC-

TION ANALYSIS,
Department of Agriculture, Forest Service,
Berkeley, California.
James R. Wallis.

Water Resources Research, Vol 3, No 2, pp 375-384, Second Quarter 1967. 10 p, 2 fig, 5 tab, 10 ref, 2 append.

Descriptors: \*Estimating equations, \*Forecasting. Identifiers: \*Linear discriminant function, \*Uncertainty categories, Factor analysis, Prediction, Stepwise procedures, Relevance.

Prediction equations for hydrologic events developed from one population of observations (Watersheds) are often solved for another population that is removed either in time or in space. Predictions of this kind are never certainties, although some predictions are obviously more uncertain than others. This paper proposes an empirical uncertainty classification that may be found useful for separating probably successful from probably unsuccessful extensions of prediction equations. The classification system is illustrated by a prediction equation for suspended sediment discharge developed from some watersheds in California, and by a discriminant function for marine versus nonmarine sediments based upon microelements. (Seneca-Rutgers) W69-00200

# SIMULATION OF GREAT LAKES BASIN

WATER SUPPLIES,
U. S. Lake Survey, Detroit and Inland Waters
Branch, Ottawa, Canada.
For primary bibliographic entry see Field 03B.

For abstract, see . W69-00201

# AUTOCORRELATION AND SPECTRAL ANALYSIS IN HYDROLOGY,

Pittsburgh Univ., Pittsburgh, Pennsylvania.
Rafael G. Quimpo.
Proc Amer Soc Civil Eng, J Hyd Div, Vol 94, No HY2, pp 363-373, March 1968. 11 p, 4 fig, 23 ref,

Descriptors: Time series analysis, Markov processes, Fourier analysis.

Identifiers: \*Autocorrelation, \*Spectral analysis, Correlogram, Spectral density, Boise River, Serial correlation coefficients.

Forty years of daily flow records of a river are analyzed using autocorrelation and spectral

# WATER RESOURCES PLANNING-Field 06

## Techniques of Planning—Group 6A

techniques. The two methods of analysis are compared relative to costs or effort and extracted information. For statistical prediction, autocorrelation is shown to be more economical. The discriminatory power of the spectral density function, which allows the detection of noncommensurable harmonics, did not carry much weight for the time series studied. A reduction in calculations can be achieved by examining the behavior of the correlogram only in the vicinity of suspected periods. In modeling, autoregressive techniques may be readily extended to the multivariate case. The intended use of the results is also a factor in the choice of methodology in data analysis. (Seneca-Rutgers) W69-00207

FINDING RESERVOIR OPERATING RULES, Federal Water Pollution Control Admin, Washing-

George K. Young, Sr.

Proc Amer Soc Civil Eng J Hyd Div, Vol 93, No HY6, pp 297-321, November 1967. 25 p, 2 fig, 4 tab, 24 ref, 2 append.

Descriptors: \*Economic efficiency, \*Reservoirs, Dynamic programming, Model studies, Monte Carlo method, Least squares method, Queueing theory, Forecasting, Regression analysis.

Identifiers: \*Operating rules, \*Optimal policies,
\*Dynamic programming algorithms, Expected loss,
Linear decision rules.

Deterministic dynamic programming is used with operational hydrology to find optimal reservoir operating rules. The objective is to find that annual operating policy of a single reservoir having an economic loss associated with each draft rate which minimizes the expected loss. (Seneca-Rutgers) W69-00209

# OPTIMIZATION OF THE OPERATION OF A MULTI-PURPOSE RESERVOIR BY DYNAMIC PROGRAMMING,

California Univ, Los Angeles.
Warren A. Hall, William S. Butcher, and Austin

Water Resources Research, Vol 4, No 3, pp 471-477, June 1968. 7 p, 3 fig, 4 ref.

Descriptors: \*Dynamic programming, \*Multiple-purpose reservoirs, \*Optimum development plans, Prices, Optimization, Reservoirs, Linear programming, River systems, California, Constraints, Risks, Planning.

Identifiers: Multiple-river systems, Shadow prices, Objective function, Maximum return.

A technique of analysis is presented by which the dynamic operation policies for planning complex reservoir systems producing hydroelectric power and providing water can be optimized for the maximum return from firm water, firm power, dump water, and dump power. The technique provides for complex constraints, such as mandatory flood control reservations variable in time, fish, wildlife, and recreational releases, navigation minimum flows, etc., as well as evaporation losses and interbasin diversions. The paper presents in detail the operational analysis of a component reservoir-river system and the procedure to be used to combine optimally a number of such sub-systems into a coordinated, mutually reinforcing, multiple-river system. (Seneca-Rutgers) W69-00219

# FACTOR ANALYSIS IN HYDROLOGY - AN AGNOSTIC VIEW, IBM Watson Research Center, Yorktown Heights,

James R. Wallis.

Water Resources Research, Vol 4, No 3, pp 521-527, June 1968. 7 p, 3 tab, 23 ref, 1 append.

Descriptors: Regression analysis.

Identifiers: \*Factor analysis, \*Antifactor analysis, Predictors, Reduced rank regression, Varimax rotation, Model building.

It is suggested that factor analysis, if used in the classical manner, will never be of great value for hydrologic analysis. However, factor analysis used as a numerical procedure for screening variables and building effective regression equations is a useful and powerful tool for hydrologic analysis that can be expected to yield equations that outperform others when they are used as predictors for control samples. (Seneca-Rutgers) W69-00220

#### WATER MANAGEMENT TOTAL. RESOURCES,

American Water Works Assoc, New York.

J Amer Water Works Assoc, Vol 59, No 4, pp 1335-1339, Nov 1967. 5 p.

Descriptors: \*Future planning (Projected), Federal government, State government, Political aspects, Social aspects, Planning, \*Water utilization, Water resources development, Administration, Water management (Applied).
Identifiers: \*Total management.

The author explores the concept of 'total management' as it relates to water development. He points out the need for total management in all areas connected with water. Before total management can come about, however, there must be a new or-ganization established to administer it. The structure of the organization must be based on institutional, jurisdictional economic, hydrologic conditions. Total management must be oriented toward planning, responsive to subjective values as well as to purely environmental factors, careful to avoid commitment to possibilities that may not materialize, and continually in search of new technology. W69-00281

#### SCALING OF ATTITUDES TOWARDS WATER CONSERVATION,

Florida Univ., Gainesville, Department of Sociolo-

gy. George A. Watkins. OWRR Project No. A-010-Fla., Master of Arts Thesis, December, 1968. 101 pp, 18 tab, 17 ref, 4 append.

Descriptors: \*Attitudes, Water conservation, \*Socioeconomic variables, Water use, Appliances, West Palm Beach, Fla., Education.

Identifiers: \*Scalogram analysis, Non-parameteric statistics, Factor analysis, Guttman scale, Urban families, Water resources problems.

An attitudinal scale was developed that might be useful to social and natural scientists and to civil engineers concerned with the water resources problem. Carried out as part of the Water Resources Research Project at the University of Florida, the data utilized were collected by inter-views with 313 residents of Palm Beach County, Florida. The interview schedules elicited specific socioeconomic information and attitudes, the latter within four subuniverses. Using the technique of Guttman scalogram analysis, the scale had an acceptable coefficient of reproducibility. To validate the four subuniverses, the attitudinal items were subjected to a factor analysis. The scale scores were then compared with the socioeconomic variables using the techniques of the Spearman rank correlation of coefficient and the Kruskal-Wallis one-way analysis of variance. Such a comparison revealed, using null hypotheses, the nature of the relationship between respondents' attitudes and their actual involvement in the water resources problem. (Author) W69-00312

A WATER RESOURCE MODEL, Stanford Univ, Palo Alto, California. Frederick S. Hillier, and Gerald J. Lieberman. Introduction to Oper Res, Holden Day, Inc, pp 423-425, 1967. 3 p.

Descriptors: \*Markov process, Multipurpose reservoirs, Mathematical model, Linear programming.

A mathematical model was presented for a hypothetical multipurpose dam. The basic assumption made was that the probabilities of inflows into the reservoir constitute a Markov chain with posi-tive recurrent states which belong to one class. By taking advantage of the steady state properties of this statistical process, a solution to the optimal release policies was suggested. Stochastic programming was suggested as one applicable technique for solution. (Gablinger-Cornell) W69-00341

#### SIMULATION TECHNIQUES FOR DESIGN OF WATER-RESOURCE SYSTEMS.

Maynard M. Hufschmidt, and Myron B. Fiering. Simulation Tech Design Water-Resource Systems. Harvard Univ. Press, Cambridge, Mass., 1966. 212 p, 51 fig, 14 tab, 42 ref, 2 append.

Descriptors: \*Simulation analysis, Water resources development, \*River basin development, Synthetic hydrology, Benefits, Costs, Digital computers, Monthly, Annual, Streamflow, Evaluation, Monthly, Annual, Streamflow, Evaluation, \*Economic efficiency, \*Computer models, \*Comparative benefits, Design.

Identifiers: Lehigh River system, Delaware River

The methodology of simulation was presented and applied to models of the Lehigh and the Delaware River systems. Alternative designs, such as structure sizes and target output levels were treated as input variables, which were arranged in various Hydrologic sequences combinations. generated in order to economically test the performances of alternative designs. System costs and benefits, including economic losses arising from output deficits, were computed. Results were summarized in terms of net benefits for various interest rates and schedules of development. The methods were illustrated by an application to an actual case, the Lehigh River. The problems of model validation were discussed. An extension of the simulation technique developed for the Lehigh to the larger Delaware system was reported. Fortran routines and study results were shown in figures and tables. (Gysi-Cornell) W69-00342

#### THE ROLE OF COMPUTERS IN PLANNING AND MANAGING WATER UTILITIES,

Harvard Univ, Cambridge, Mass.

J New England Water Works Ass, Vol 81, No 3, pp 231-257, Sept 1967. 27 p, 9 fig, 2 tab, 18 ref.

Descriptors: \*Analytical techniques, \*Digital computers, Economic efficiency, Hydraulic design, Linear programming, Dynamic programming, Mathematical models, \*Planning, \*Utilities, \*Water management (Applied), Systems analysis ontimization. Network design. Distribution. Network design, Distribution optimization,

Identifiers: Newton-Raphson method, Geometric programming, Dual variable.

The role of the digital computer in the planning and management of water utilities was discussed, and several hypothetical examples of programming methods were presented. The Newton-Raphson technique was used to solve for the flows in a simplified hydraulic network. A linear programming model of a production process was developed to find the optimum output for a manufacturer. The importance of the dual variables was discussed, and the dual problem was structured for the above example. The theory of geometric programming was summarized and applied to the design of a sedimentation basin. An example of a water-meter replacegramming was given. Procedures and results of the

## Group 6A-Techniques of Planning

examples were demonstrated in tables and figures. (Gysi-Cornell) W69-00344

TOWARDS ECONOMIC EVALUATION OF WATER QUALITY IN IRRIGATION,

Harvard Univ, Cambridge, Mass; Colorado State Univ, Ft. Collins.

D. Yaron, and E. Bresler.

Proc Int Conf Water For Peace, Washington, D C, Pap P/654, May 1967. 12 p, 2 fig, 1 tab, 13 ref.

Descriptors: \*Linear programming, Salt balance, \*Water quality, \*Evaluation, Irrigation water, \*Ir-rigation efficiency, Salinity, Chlorides, Salt rigation efficiency, Salinity, Chlorides, Salt tolerance, Soil properties, Marginal return, Leaching, Evapotranspiration, Soil water optimiza-

Identifiers: Marginal substitutuion rate

A linear programming model was developed and used to find the optimal combination of irrigation water quality and quantity. State variables, such as initial salt concentration of the soil, evapotranspiration rates, depth, and bulk density of soil layers, were assumed given. The salt concentration of irrigation water was the decision variable to be maximized, subject to maximum soil chloride concentration levels, and a continuity salt balancing constraint for the soil. The problem was repeatedly solved for various given irrigation rates. The results of a hypothetical example were tabulated and graphed. The individual solutions when plotted gave an 'iso-soil-salinity' curve for a maximum allowed soil salt concentration. It was concluded that the optimum point on the curve was that point the optimum point on the curve was that point where the marginal rate of substitution of water salinity for quantity just aqualled the unit cost rates of quantity increase to quality increase. (Gysi-Cor-W69-00345

AN INVESTIGATION OF ALTERNATIVE MEANS OF ACHIEVING WATER QUALITY OBJECTIVES,

Oregon State Univ, Corvallis.

Kenneth D. Kerri.
Ph D Thesis, Dept Civ Eng, Oregon State Univ,
Corvallis, June 1966. 177 p, 26 fig, 23 tab, 47 ref, 3

Descriptors: \*Comparative costs, Computer programs, Dissolved oxygen, Coliforms, Economic efficiency, Constraints, Flow augmentation, Mathematical models, \*Water quality control, Reservoir storage, Regression analysis, Waste assimilative capacity, \*Waste dilution, \*Waste treatment. Identifiers: Non-linear programming, Willamette River Oregon

Non-linear programming techniques were used to find the minimum cost of achieving various water quality objectives in the Willamette River Basin in Oregon. The objective of the study was to test the hypothesis that 'the waters of the Willamette are too costly for pollution abatement'. An analytical model consisting of two digital computer programs was developed. The minimum cost for removal of a certain quantity of BOD was obtained from a 'DO cost of treatment' matrix. That solution was inserted in the Streeter-Phelphs oxygen sag equation to predict the DO profile for the river. Regression analysis was used to compute costs of meeting coliform standards, and to determine costs of flow augmentation for waste dilution. All the studies were combined to find the minimum cost of treatment and storage to meet various quality standards and flow levels. Results in the form of the hypothesis acceptance or rejection were shown in tabular form. (Gysi-Cornell) W69-00346

ON THE OPTIMUM RECORDING OF A TYPE OF HYDROLOGICAL DATA,
Delft Technological Univ, The Netherlands.
For primary bibliographic entry see Field 07B.
For abstract, see .

W69-00347

MANAGEMENT MODELS FOR WATER RESOURCE SYSTEMS, Cornell Univ, Ithaca, NY.

Daniel P. Loucks.

Tech Rep 1, Cornell Univ Water Resources Center, June 1967. 130 p, 18 fig, 8 tab, 241 ref.

Descriptors: Estimated benefits, Flow augmentation, \*Linear programming, Probability, Economics, \*Reservoir operation, River regulation, Seasonal, Stochastic processes, Mathematical models, \*Water management (Applied), Water resources, \*Water allocation (Policy), Optimization, Constraints, Oxygen sag. Identifiers: Loss functions, Suboptimization.

Deterministic and stochastic linear programming models were structured and used to determine the reservoir releases and the allocations of water to each flow and stock use that meet some management objective. Three objectives incorporated into the model were: (1) max total expected net benefits; (2) min total expected net losses; and (3) min total expected deviation from each use's 'target' (if no economic benefit-loss data was available). Two deterministic times ble). Two deterministic linear programming models for water quality management were discussed. The models indicated the minimum cost required to maintain particular DO standards within the system, and the increase in costs resulting from any social, legal or administrative constraints. It was suggested that partial water quality control could also be achieved through appropriate allocations of water for wastewater dilution and transport. Extensions of the models and some economic implications were presented in the appendix. (Gysi-Cornell) W69-00348

# OPTIMUM OPERATION OF A MULTI-RESER-VOIR WATER SUPPLY SYSTEM.

Stanford University, Stanford, California.

Reuven Amir.

Program in Eng Econ Planning, Stanford Univ, Rep EEP-24, May 1967. 129 p, 15 fig, 30 ref, 2 append.

Descriptors: Dynamic programming, \*Reservoir operation, \*Water supply, Water demand, Water costs, Water allocation (Policy), Variable costs, Stochastic processes.
Identifiers: Principle of Optimality.

mathematical model for reservoir operation using the principle of optimality of dynamic programming was presented. A system of dams and conduits was assumed to exist. The inflows were assumed to be stochastic. Water demand was assumed a predetermined function of time. The objective was to avoid excess demand, considering the costs of shortage and operation. The decision variables were either reservoir levels or changes in reservoir levels. The state variables were the time left for the operation of the system, the amount of water stored in the reservoirs, and all the past inflows. The problem was analyzed as a single reservoir and as a generalized multi-reservoir system. Optimal policies were obtained under various simplified cost assumptions. (Gablinger-Cornell) W69-00349

## A SYSTEMS ANALYSIS OF THE LOWER GANGES-BRAHMAPUTRA BASIN, Harvard Univ, Cambridge, Mass.

Pap, UNESCO Int Symp on Floods and Their Computation, Leningrad, Aug 15-22, 1967. 26 p, 3 fig,

Descriptors: Systems analysis, Linear programming, Decision making, \*River basin development, \*International waters, Negotiations, Hydroelectric power, Irrigation, Salinity, Water policy, Navigable rivers, Flood control, Political constraints, Benefits, Optimum development plans. Identifiers: India, East Pakistan, Ganges-Brahmanutra Rasin Game theory. Screenies reddel maputra Basin, Game theory, Screening model.

A deterministic linear programming model w structured and used as a preliminary screening model of the Lower Ganges-Brahmaputra Rive Basin. The objective was to maximize the n returns from hydropower production and irrig tion, subject to flood control, salinity, navigation system capacity and continuity constraints. The model was solved several times using adjustment on the constraint set to reflect various internation policy decisions that could be considered by Indi and East Pakistan. The solutions to the various a ternatives were then considered within the framework of game theory. The results were show as a payoff matrix and as a geometrical representa tion of a co-operative two-person non-zero-sui game. It was concluded that the techniques e systems analysis could aid in determining guidelines for negotiation on river basin develop ment at the international level. (Gysi-Cornell) W69-00350

# OPERATIONS RESEARCH APPLIED TO ENGINEERING PLANNING, Tennessee Technological University, Cookeville.

For primary bibliographic entry see Field 06C. For abstract, see. W69-00351

#### OPTIMIZATION **METHOD** FOL BRANCHING MULTISTAGE WATEL RESOURCE SYSTEMS,

Texas A and M University, College Station; Univer

W. L. Meier, Jr., and C. S. Beightler.
Water Resources Res, Vol 3, No 3, pp 645-652
Third Quarter 1967. 8 p, 6 fig, 11 ref.

Descriptors: \*Dynamic programming, Rive systems, Optimization, Planning, Mathematica models, Water resources, Correlation analysis \*Reservoir operation. Identifiers: Serial systems, Branching.

Dynamic programming was used to structure a planning model of branching multistage nonseria water resources systems. Maximum return was ob water resources systems. Maximum return was obtained by decomposing the nonserial river basin system into equivalent serial systems. The use of this method involved introduction of a cut state at the junction between the branch and serial chain The state variables were the cut states and the reservoirs storages, the decision variables were the releases from the reservoirs. A hypothetical example was solved. (Gablinger-Cornell) W69-00353

#### RISK EVALUATION IN SEWAGE TREATMENT PLANT DESIGN,

Cornell Univ, Ithaca, NY. Daniel P. Loucks.

Amer Soc Civil Eng Proc, Vol 93, No SA 1, pp 25 39, Feb 1967. 15 p, 9 fig, 7 ref, 2 append.

Descriptors: Stochastic processes, Standards, Cor relation analysis, Water policy, Digital computers Diffusion, Dissolved oxygen, Economic efficiency \*Waste storage, \*Mathematical models, Oxygersag, Probability, \*Risks, \*Sewage treatment \*Evaluation, Water quality control, Design flow Oxygen requirements, Constraints.
Identifiers: Probabilistic model, Transition proba

bilities, Plant design.

A Markov model was developed to predict, for an particular consecutive-day period, the probability of having less than any specified dissolved oxyger concentration downstream from a waste wate treatment plant. The model allowed for both seria and cross correlation between average daily stream and sewage flow conditions. From the probabilitie and sewage flow conditions. From the probabilitie provided, the risk of violating of any stream stan dard or effluent standard could be determined. The probabilistic model was illustrated using hypothetical example. Results of the model, including the effect of effluent storage on the cumulative probability distribution of minimum DO concentrations were above. It was shown that the variability tions were shown. It was shown that the variability

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of a stream's waste assimilative capacity might be used to advantage by means of effluent storage.
Computer flow diagrams for determining the maximum allowable BOD concentration in a stream and for solving the model were appended. (Gysi-Cornell)

W69-00354

WATER OUALITY MANAGEMENT,

Univ of Oklahoma, Norman.

George W. Reid. Water and Wastes Eng, Vol 4, No 11, pp 50-51,

Nov 1967. 2 p, 1 fig.

Descriptors: Flow augmentation, Future planning (Projected), Input-output analysis, Mathematical models, Systems analysis, Water demand, \*Water management (Applied), Water pollution, Water pollution treatment, \*Water quality control, pollution treatment, Stream improvement.

Identifiers: Nutritional chemicals, Persistent

chemicals.

A brief history of some water supply shortage problems was given, and the use of pollution abatement as a first step towards increasing water supplies was suggested. Some of the fundamentals of water pollution were presented, including the various types of pollution usually encountered. Five equations that can be used for estimating required waste water treatment and streamflows for five different types of pollutants were given. The equations would be used as input-output transformations and would be integrated into a system and analyzed. A mathematical model for a single discharge waste and receiving stream was diagrammed. It was proposed that the approach to the solution of water resource availability be directed toward an optimal combination of waste treatment and low-flow augmentation from storage. (Gysi-W69-00355

A LEAST COST EVALUATION OF DISPOSAL SYSTEMS FOR LOW RADIOACTIVE WASTES, LOW LEVEL LIQUID

Harvard Univ., Cambridge, Mass. Walter O. Spofford, Jr., and Harold A. Thomas, Jr.

Oper Res Disposal Liquid Radioactive Wastes in Streams, Harvard Water Resources Group, Part 2, Dec 1967. 33 p, 7 fig, 5 tab.

Descriptors: \*Radioactive waste disposal, Analytical techniques, Diffusion, \*Economic efficiency, Liquid waste, Evaluation, Cost analysis, Mathematical models, Parametric hydrology, Reservoir storage, River flow, Waste water treatment, Waste storage, Water treatment, \*Water quality control. Identifiers: \*Lagrange multipliers, Deterministic models, Steady state.

Lagrange multipliers were used in the analysis of a simplified waste handling and treatment scheme on stream. Deterministic steady state stream flows were assumed. The objective was to minimize the sum of the costs at an upstream waste treatment plant and a downstream water treatment plant. The water quality produced by water treatment plant was constrained to be greater than some value. The decision variables were the various combinations of efficiency for each of the plants, and the state variables were the physical and hydrologic parameters. Two examples, with and without assumed reservoir storage, illustrated the use of the model. Important concepts of systems analysis such as: (1) optimal economic design; (2) problem identification; (3) error analysis; and (4) optimal allocation of funds for future data collection were illustrated and discussed. One of five chapters in 'Operations Research in Disposal of Liquid Radioactive Wastes in Streams.' (Gysi-Cornell)
W69-00356

QUEUEING THEORY AND RESERVOIR Harvard Univ, Cambridge, Mass.

Peter Watermeyer, and Harold A. Thomas, Jr. Proc Harvard Symp Digital Computers and Thier Appl, Ann Comput Lab Harvard Univ, pp 59-76, Apr 1961. 18 p, 5 fig, 14 tab, 16 ref.

Descriptors: \*Markov processes, \*Reservoir operation, Reservoir design, Multiple-purpose reservoirs, Benefits, Linear programming, Optimization, Computers.

Stochastic linear programming was used to obtain an optimum operating policy connecting reservoir drafts with initial storages and flows. The objective was to maximize the expected value of benefits associated with various target drafts in various periods, subject to probability constraints. Serial correlation of the inflows was assumed and illustrated in probability matrices. The decision variables were the joint probabilities of an initial storage, inflow, and draft for any period. Two hypothetical examples illustrated the use of the model. The first example assumed one period per year, one benefit, and three possible flows. The second example assumed two periods per year, four possible flows, and three possible benefits. Results of the examples were shown in tabular form. (Gysi-Cornell) W69-00357

MODEL FOR DESIGNING WATER DIS-TRIBUTION PIPE NETWORKS,

Harvard Univ, Cambridge, Mass.

Ramachandran Pitchai.

Harvard Water Resources Group, Ph D Thesis, Harvard Univ, June 1966. 324 p, 42 fig, 25 tab, 79 ref, 9 append.

Descriptors: Digital computers, Design criteria, Design flow, \*Distribution systems, \*Economic efficiency. Estimated benefits, Estimated costs, Discount rate, \*Hydraulic design, \*Mathematical models, Pipes, \*Network design, Pumping, Statistical methods, Water distribution (Applied), Water demand, Hydraulic properties.

Identifiers: \*Non-linear integer programming, Sensitivity analysis.

Non-linear integer programming was used to find the optimum (least cost) design for the pipes in a water distribution system. The objective function to be minimized included pipe costs and the present value of annual pumping costs (both functions of the pipe diameters). The constraint set consisted of pipe friction formulas, Kirchoff laws, minimum permissible and commercially available pipe sizes, maximum permissible head losses, and pump characteristic curves. The network balancing algorithm was based upon the Newton-Raphson convergence method. Sequential random sampling techniques were applied to test system designs in the 'neighborhood' of an original 'reasonable' design. The use of a probabilistic approach for benefits was recommended. A sensitivity analysis on all the model parameters indicated that benefit and cost coefficients played an important role, and further research in their precise evaluations was recommended. (Gysi-Cornell) W69-00358

TECHNIQUES FOR FINDING RESERVOIR OPERATING RULES, Harvard Univ, Cambridge, Mass

Ph D Thesis, Div Eng Appl Phys, Harvard Univ, Nov 1966. 89 p, 13 fig, 8 tab, 24 ref, 3 append.

Descriptors: \*Dynamic programming, \*Reservoir operation, Synthetic hydrology, \*Simulation analysis, Markov processes, Streamflow forecasting, Optimization, Water allocation (Policy), Stability, Digital computers, Statistical methods, Water management (Applied), Regression analysis, Probability.
Identifiers: Target drafts, Loss function, \*Deterministic, \*Forward looking.

A deterministic, forward looking dynamic programming algorithm, together with hydrologic simulation, and regression techniques to find the optimal operating policy of a single reservoir. The objective was to minimize the sum of economic loss resulting from draft rates missing the target flow for an assumed maximum reservoir capacity. Other an assumed maximum reservoir capacity. One dynamic programming algorithms (backward-deterministic, and forward-and backward-stochastic) were discussed. A Gaussian lag-one Markov model was used to simulate inflows. The effect of the number of years studied on the first year draft decision was investigated. Optimal policies were obtained for various hypothetical loss functions. The policies were inferred by studying sequences of allocations resulting from the algorithm operating on simulated inflow sequences. A flow forecast model was derived, and used to investigate the value of inflow forecasts. It was concluded that the model was efficient for the objectives defined. (Gysi-Cornell) W69-00359

#### 6B. Evaluation Process

SOUTHWESTERN JEFFERSON COUNTY, KEN-TUCKY, FLOOD CONTROL PROPOSAL. U. S. Army Corps of Engineers, Washington, D. C.

U. S. 90th Congr, 2d Sess, House Doc No 340, 80 p, 1968. 2 plate, 1 attach, 4 append.

Descriptors: \*Recreation facilities, \*Flood control, \*Cost-benefit analysis, \*Kentucky, Floods, Flood damage, Flood plains, Levees, Design criteria. Identifiers: \*Jefferson County, Kent Kentucky, Louisville area, Flood Control Act.

Flooding in southwestern Jefferson County, Kentucky, was investigated and a plan for construction of local flood protection works, including an impoundment with recreational facilities, presented. The area covers 41 sq miles of the Ohio River flood plain downstream from and contiguous to the existing flood control works of Louisville. Property worth \$256,100,000 is in the overflow area. Future developments having a value of \$409,300,000 are projected to 1975 without flood protection. Average annual flood damage now is \$239,300. Levees and walls are the only practical flood protection. The planned works include an earth levee and a short concrete wall supplemented by 2 pumping plants and an 810 acre impoundment. The impoundment will be developed for recreation. Total first cost is \$20,700,000, of which \$14,050,000 is federal. Annual charges are \$1,015,000 and benefits are \$2,143,000, yielding a benefit-cost ratio of 2.1:1. Most of the annual benefits are recreational. (Knapp-USGS) W69-00085

CLEAR CREEK, TEXAS, FLOOD CONTROL PROPOSAL.

U. S. Army Corps of Engineers, Washington, D. C.

U. S. 90th Congr, 2d Sess, House Doc No 351, 55 p, 1968. 1 plate, 1 attach, 4 append.

Descriptors: \*Flood control, \*Channel improvement, \*Texas, Cost-benefit ratio, Floods, Flood damage, Design flood.
Identifiers: \*Clear Creek, Texas, Flood Control

Act, Spoil disposal.

Flood control plans for Clear Creek, Texas, about half way between Houston and Galveston, are presented. The 250 sq mi watershed of Clear Creek basin slopes from 70 to 5 ft above sea level. Parts of the cities of Houston, League City, Pearland, Friendswood, Brookside Village, and Webster are within its flood plain. Present flood control measures are not adequate. Floods result from intense local thunderstorms, general storms, and torrential hurricane rainfall. The value of property in the floodplain is \$23,774,000. Based on growth projections, physical property values are expected to increase to about \$427 million by 2070. A standard project flood under existing conditions of development would cause damages of \$5,532,000; annual

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average damage is \$578,000. The only feasible solution is channel enlargement and rectification to protect against the 100 yr flood. First cost is estimated to be \$18,900,000 of which \$12,600,000 is federal, and the benefit-cost ratio is 2.9. (Knapp-USGS) W69-00087

#### COMPETITION FOR RECREATION WATER IN CALIFORNIA.

U.S. Army Engineer District, Sacramento, Calif. Amalio Gomez, and Dale A. Crane. ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR3, Pap 6109, pp 295-307, Sept 1968. 13 p, 2 fig.

Descriptors: \*Multiple-use projects, \*Reservoirs, \*Recreation facilities, \*Reservoir operation, \*Water allocation (Policy), \*California, Cost comparisons, Cost-benefit ratio, Water rights, Public benefits, Federal Project policy.

Identifiers: \*Recreation water, \*Water competition, Public demand, California Water Code.

Tremendous growth in recent years of water-oriented recreation has brought about great demand for minimum recreation pools and adequate facilities at reservoir projects. Water pools for recreation require acquisition of water to fill them initially and to compensate for added evaporation losses later. Such requirements are highly competitive with other established uses. This difficult problem was satisfactorily solved in 4 Federal reservoirs in a water-deficient area in California. Procedure used required a high degree of cooperation by water users, public at large, and construction agency. Required water for recreation was estimated at less than 0.5% of natural stream flow. Total cost, including storage, water, recreation facilities, and maintenance and operation is estimated at \$0.30 per recreation-day. Under Public Law 89-72 about one half of this cost would be borne by the Federal Government and the other half by a local agency. Local costs can be financed through user fees. (Lang-USGS) W69-00101

# WATER NEEDS IN 1999,

Horner and Shifrin, Cons. Engr., St. Louis, Missou-

ri. Vance C. Lischer.

ASCE Journal of the Urban Planning and Development Division, Vol 93, No UP1, Proc Paper 5061, pp 13-20, Jan 1967, 8 pp.

Descriptors: Energy conversion, Plumbing, \*Waste water disposal, \*Water utilization, \*Water re-use. \*Resources, \*Supply Identifiers: Forecasting, Conservation.

The paper is an expression of the writer's observations of trends in technology and water use by people and industry. It deals with these with respect to water and waste disposal practices which are expected to have an impact on water needs in 1999 and on the manner in which these needs are satisfied. Predictions into the future must recognize advancing technology, but must take into account that water-use habits are often tradition-bound, and are not always rational. (Grossman-Rutgers) W69-00170

#### INSTITUTIONAL CONSTRAINTS AND ECONOMIC OPTIMA - A BASIS FOR MANAGEMENT DECISIONS IN INTRARE-GIONAL WATER TRANSFER,

California Univ., Berkeley, California Agricultural Experiment Station.

Land Economics, Vol 44, No 2, pp 173-184, May 1968, 12 p, 17 ref.

Descriptors: \*Water management (Applied), Pumps, Ground-water, Overdraft, \*Water alloca-tion (Policy), Legal aspects, \*Political aspects, Cost-benefit analysis.

Identifiers: Economics, \*Water transfer, \*Institutional constraints.

This analysis emphasized the evaluation of political-institutional processes, legal structures, adcar-institutional processes, legal structures, administrative techniques insofar as they effect the water economy. The ground-water overdraft problems of the Salinas Valley of California was the focal point of the analysis. A positive corrective action was called for, but the existing physical, in-stitutional, and political environment of the area presented a strong constraint upon the efficiency implication of an optimal water policy. A traditional solution based on economic analysis of costs and benefits had to be qualified since: (1) an inefficient solution may be judged socially superior to an economically efficient solution, (2) the traditional solution does not consider the effect of private and social interests, (3) costs associated with overdrafting a ground-water reservoir are nonseparable, and (4) a traditional solution implicitly assumes control over all variables. A solution within a modern water context may entail one or more of the following schemes: (1) efficiency aspects: adjudication, (2) pump tax, and (3) equity aspects. (Grossman-Rut-W69-00171

### ECONOMICS OF WATER POLLUTION,

Dept. of Agriculture, Economics Research Service. For primary bibliographic entry see Field 05C. For abstract, see . W69-00172

#### WATER RESOURCE PLANNING IN NORTH CAROLINA.

North Carolina State Dept. of Water Resources, Raleigh.

North Carolina Dept. of Water Resources, Raleigh, N.C. July 1964, 214 pp, 11 illus, 15 tab, 41 ref, 1 append.

Descriptors: Political aspects, State governments, Water management, \*Water supply, \*Pollution abatement, Recreation, Flood damage.

Identifiers: North Carolina Department of Water Resources.

Included in this report is a comprehensive survey of water resources planning; an inventory of existing plans, a generalized projection of short, medium and long range program needs, and a preliminary blueprint of some planning guidelines for the fu-ture. Outlined in detail are the economic background and population trends, with a discussion of their impact on water resources for the future. A review of existing water resource programs in North Carolina in pollution abatement, water supply recreation, flood damage protection and the organization and administration of the programs is discussed, along with a detailed explanation of their functions. The financing by local, state and federal government is reviewed. After this specific discussion of North Carolina water resource planning, there is a general discussion of the role of planning in water resource development. Water resource planning and trends in other states are reviewed. In conclusion, recommendations for future water resource planning with organization for implementation are given. (Gargola-Chicago) W69-00173

# INTERGOVERNMENTAL RESPONSIBILITIES FOR WATER SUPPLY AND SEWAGE DISPOSAL IN METROPOLITAN AREAS. Advisory Commission on Intergovernmental Rela-

Advisory Comm. on Int. Relations, Report No. A-13, Wash., D.C. Oct. 1962, 135 pp., 5 tab, 72 ref, 2

Descriptors: Economies of scale, Water rates, Political aspects, Water quality control, State jurisdiction, Water allocation, Legislation. Identifiers: Multipurpose vs. single purpose.

Discusses the problems of urban water quality and quantity, regional variations, and the difficulties of balancing and adjusting varying governmental in-terests. Local water problems of inadequate invest-ment, failure of individual systems, and the fragmentation of this public function are examined in detail. Various metropolitan approaches are given; arguments for a comprehensive plan include the economics of scale, equalization of water and sewer rates, and fewer unwise investments. Considered then are the political realities in relation to these approaches; the difficulties of the multi-purpose approach are discussed in comparison with the easily implemented single-purpose plans. The state's role in urban water planning is reviewed in the areas of allocation, regulation, facilitation and development. Concerning governmental involve-ment, suggestions for the role of the federal government in quality and quantity control are given. It is decided that the problems of water resource management are more governmental than technical; ten suggestions for future developments, with plans to implement them are then given. In conclusion, models for acts - State Water Resources Planning and Coordination Act, and Control of Urban Water Supply and Sewerage Systems are suggested. (Gargola-Chicago) W69-00174

#### ROANOKE VALLEY REGION WATER RESOURCES PLAN.

Howard, Needles, Tammen and Bergendorf.

Roanoke Valley Regional Planning Comm, Dec. 1967, 90 p, 38 plat, 90 tab, 24 ref.

Descriptors: Land-use, Water supply, Waste disposal, Urbanization, Economic resources, Non-structural alternatives, Financing. Identifiers: Roanoke Valley, Va., Roanoke, Va.

This comprehensive regional plan provides the framework for solving the immediate and long range water and sewerage problems of the Roanoke Valley Region. The plan is based on certain relevant considerations of population, and its relation to topography, land use and zoning. Existing sources of water are reviewed, with the conclusion that existing facilities will no longer adequately serve the region by 1975. Possibilities of new sources are explored. Under the proposed plan, distribution of water would be accomplished by means of an inner and outer loop system which would center on the city of Roanoke. Construction of a dam, water treatment facilities, transmission pipe lines, and major distribution lines with sewerage treatment works form the bulk of the proposed plan. A Regional Water and Sewer Commission or similar organization is proposed which would administer, maintain and develop the facilities. A plan of bond financing is outlined for acquiring and constructing the system. (Gargola-Chicago) W69-00175

# WATER FOR ILLINOIS: A PLAN FOR ACTION. Illinois State Gov't., The Technical Advisory Committee on Water Resources.

The Technical Advisory Committee on Water Resources, State of Ill., March 1967, 452 pp, ap-prox. 170 fig, approx 150 photo, approx. 100 tab, 73 ref.

Descriptors: Water sources, Water supply, Pollution abatement, Recreation, Water law, River basin planning, Navigation.

Identifiers: Illinois, Bellwood, Ill., Bloomington-Normal, Ill., Carbondale, Ill., Chicago, Ill., Joliet, Ill., Decatur, Ill., Lombard, Ill., Peoria, Ill., Pekin, Ill., Moline, Ill., Urbana-Champaign, Ill., Madison

Contained in an overall, comprehensive discussion of Illinois water resources, economy, and popula-tion trends. A discussion of water supply and use with case studies in Illinois is given. Of the studies, most significant as an example of metropolitan development is the Chicago study. Here a history of

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water supply and ownership is given and pollution problems and their present solutions are discussed. The advantages of the lake and problems of pollution abatement are reviewed and suggestions for a further improved water supply are given. Also discussed are the problems of urban occupance of agricultural levee districts. Plans for water based recreation in Illinois are outlined with suggestions for future developments and possibilities for funding from state, local, and federal sources. The ways and means through which the State and its subivi-sions, assisted by federal aids, meet their responsibilities in water resource management is defined. A review of organization and funding in other states is done. Navigation and runding in other states is done. Navigation and river basin planning are discussed and suggestions for future developments proposed. (Gargola-Chicago) W69-00176

WATER RESOURCES IN THE RFF PROGRAM, Resources for the Future, Washington, D. C.

Allen W. Kneese. In Resources for the Future, Washington, D. C., March 1964, 70 p.

Descriptors: Discount rate, Cost-benefit analysis, \*River basin development, \*Recreation, \*Water supply, \*Decision making, Water pollution, Flood damages, Political aspects.

Provided is a general background of programs and studies being carried on in pollution, river basin development, recreation, water quality, public interest in water resources and increased water supply. A general review of works published in these areas is also included. Outlines of areas needing study are suggested with plans for allocation of funds to them. A review of studies of particular benefit/costs associated with water resource development and use is given: (1) water quality aspects of recreation value-with studies under way or completed; (2) aspects of water quality in relation to salinity, treatment, and stream flow regulation; and (3) control of flood damages. Following is a discussion of system optimization and other general problems of decision making in the public interest. Some of the specific problems examined are: (1) geographical extent of the water resources planning and operating unit; (2) discounting for the future; and, (3) uncertainty of outcomes of public investment. Discussed are the ways political decisions and optimization analysis might be facilitated. General studies of policy issues and the role of the political process in water development is reviewed. Case studies underway in relation to the abovementioned areas are reviewed. (Gargola-Chicago) W69-00178

METROPOLITAN PLANNING AND RIVER BASIN PLANNING: SOME INTERRELATION-

Water Resources Center, Georgia Institute of

Technology, Atlanta. Guy J. Kelnhofer, Jr.

Office of Water Resources Research, project B-009-GA, July 1968. 231 p, 13 fig, 6 tab, 229 ref.

Descriptors: \*Metropolitan planning, \*River basin planning, Metropolitan water management, Metropolitan areas, \*River basin development, Metropolitan resources development, Georgia, Coordination, \*Public development attitudes, Project planning, Decision making, Urbanization, Resource allocation, Public interest, Federal projects, City planning. Identifiers: \*Atlanta metropolitan area, \*Chat-

tahoochee River, Metropolitan planning agencies.

The relationships that exist between the planning of river basins and the planning of metropolitan areas in the management, use and development of water resources are examined. How, and the extent to which metropolitan area governments participate in decisions for water resources use and development in their regions is discussed. Attention is focused on the important aspects of the problem of planning for water resources management and use in metropolitan areas. Most metropolitan areas were found to be handicapped because no one metropolitan government is authorized represent the metropolitan area and negotiate with river basin interests; and usually, there is no river basin management agency with whom metropolitan representatives could negotiate. Significant changes that could be made in local. State and Federal water planning procedures are suggested that, if implemented, metropolitan areas would have more and better control over the development and use of their water resources. Contains 229 references. (Water Resources Center-Ga Tech)

#### NORTHERN CALIFORNIA'S WATER INDUS-TRY.

Resources for the Future.

Joe S. Bain, Richard E. Caves, and Julius Margolis.

In Johns Hopkins Press, Baltimore, Md., 1966, pp 1-17, 8 ref.

Descriptors: Water values, \*Water supply, \*Pricing, Water rates.

Identifiers: Northern California, \*Theory of market. \*Market models.

An 'industry study' takes as its frame of reference the structural taxonomy of market models, and is the approach used in dealing with the water supply and demand problem in this study of northern California. Presented is a regional water industry, examining from a clinical point of view its actual structure, conduct and performance. The aim of the study is ultimately that of deriving proposals for public policy affecting development of water resources. In the first stage, adapting the theory of markets, six distinctive features of the water industry are discussed. The second stage identifies important observable elements of the structure or environment of the industry that may have economic significance for explaining the character of its behavior and the quality of its performance. From this, further development of the industry study approach to water problems is outlined. (Gargola-Chicago) W69-00186

# POLICY HORIZONS FOR FUTURE URBAN WATER SUPPLY, Resources for the Future.

J. W. Milliman.

Land Economics, Vol. 39, pp. 109-32, May 1963 21 pp, 2 fig, 1 tab, 26 ref.

Descriptors: Average price, Average costs, Discriminatory pricing, \*Water rates, Unit costs, \*Water supply, Marginal costs, Marginal benefits, \*Peak loads

Identifiers: Metering, Block rates, \*Urban water economics.

Considering its importance, urban economics does not hold a proper place in the field of water resource management. Three factors are responsible for this: the technology of municipal water supply has not greatly changed in 2000 years; economic costs of urban water supply have been very low in relation to worth; and the area has never been the subject of heated partisan debate. In the future this will change, and certain emerging policy issues will become more important. The role of technology, economics, and political decisionmaking are discussed, with reference to possible future trends. Problems of metering, price dis-crimination, block rates, and peak load are sur-veyed against a backdrop of rising water costs and the need to promote efficient water use. Suggestion for increasing the efficiency of urban water management is given, with a critique of established practices in setting level of water rates. (Gargola-Chicago) W69-00187

#### TRI-COUNTY RIVERFRONT STUDY.

Tri-County Regional Planning Commission, Peoria, Tazewell, Woodford Counties, Ill.

Tri-County Regional Planning Commission, Peoria, Ill., Feb. 1968, 85 pp, 21 illus, 2 appen.

Descriptors: Geology, \*Land use, Water quality, Watershed, \*Future planning, \*Water zoning.
Identifiers: Illinois River, Peoria, Woodford, Tazewell, \*Riverfront planning.

Because a waterfront can be of great value in stimulating community development and facilitating industry it should be guarded against improper use. This study attempts to explore the Tri-County Illinois River development from two viewpoints; first, the Illinois River in terms of regional significance; secondly, the Tri-County riverfront area in relation to a more immediate geographic area. The physical characteristics and regional uses of the river are discussed. Background data, with implications for planning are outlined, and existing land use reviewed. Barge industry statistics are given with an outline of development in that industry. Guidelines for future development to preserve balance between private uses and public recreation and conservation needs are outlined. Shoreline and water surface conservation emerges as one of the most pressing needs. The present problems of the area reflect future needs, and recommendations are made from these. In conclusion a brief view of other successful waterfront projects is given. (Gargola-Chicago) W69-00189

#### COMPETING USES FOR WATER AND OTHER IMPEDIMENTS TO IRRIGATION DEVELOP-MENT,

North Dakota State Univ., North Dakota Water Resources Institute.

Thor A. Hertsgaard.

Great Plains Agricultural Council, Publication No 30, pp 23-28, Nov 1967, 6 p, 1 ref.

Descriptors: \*Cost-benefit analysis, \*Economic efficiency, \*Productivity, Prices, Water utilization, Resource development, \*Water rights. Identifiers: \*Economics, \*Irrigation, \*Water demand.

Water resource development projects are chosen on the basis of the benefit-cost ratio of the projects. Further, the outlay for the projects is warranted up to the point where marginal resource cost equals the marginal revenue product of the outlay. The problems of this method of project selection are discussed. If pure competition existed in a water resource market, then the market mechanism would allocate the water so that the marginal value product of water would be identical in all the uses of the water. Thus, the economic efficiency of water use would be maximized. The competition for water is not pure, so the market-price mechanism is not economically efficient. The alternative method of allocation is by use of water rights. This two has proven to be economically inefficient. Information needed to guide the choice of uses of water that will be consistent with maximum economic efficiency is given in the paper. (Grossman-Rutgers) W69-00192

RIVER BASIN PLANNING AND URBAN DEVELOPMENT,

Georgia Inst. of Tech., Atlanta, Georgia, School of Architecture.

Guy J. Kelnhofer, Jr.

ASCE Journal of the Urban Planning and Development Division, Vol 93, No UP4, Proc Paper 5619, pp151-161, Dec. 1967 11 pp.

Descriptors: \*Community development, Federal Government, Coordination. Identifiers: \*Planning, \*River basin development.

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The coordination of river basin planning and metropolitan planning are important. Planning for river basin development should be brought under a unified command. The common objectives and plans of metropolitan areas must be based on a consensus. The increasing Federal emphasis on metropolitan planning and the creation of river basin planning agencies are two promising trends in the development of closer coordination in the planning of river basins and metropolitan areas. (Grossman-Rutgers) W69-00194

#### IRRIGATION IN THE FUTURE,

Leeds, Hill and Jewett, Inc., Cons Engrs, San Francisco, California.

Harvey O. Banks

ASCE Journal of Urban Planning and Development Division, Vol 93, No UP1, Proc Paper, pp 41-55, Jan 1967. 15 pp, 1 map, 5 tab, 10 ref.

Descriptors: \*Projections, Federal Government, Federal Reclamation law, \*Water policy, Resources.

Identifiers: Irrigation programs, \*Future planning (Projected).

Projections of need for irrigated agriculture in the next 50 years were calculated for three areas. For California, irrigated acreage is projected to increase by one-third; in Texas, to more than double; and in the Erie-Niagara Basin, of western New York State, to increase nine times. For these projections it was assumed that water will be available at prices within irrigator's payment capabilities. Also, technological advances were postulated. Future irrigated agriculture probably will not be able to pay the full cost of supplying irrigation water. The continuing need for subsidy must be recognized and a uniform nation-wide policy should be adopted by the Federal Government. The price for irrigation water from Federal projects should be high enough to encourage efficient use. Acreage limitation provisions of Federal Reclamation law should be modernized to promote efficient agriculture. (Grossman-Rutgers) W69-00195

# FRAMEWORK FOR ANALYSIS OF IRRIGA-TION DEVELOPMENT, Oklahoma State Univ., Stillwater, Department of

Agricultural Economics. Vernon R. Eidman.

Great Plains Agricultural Council, Publication No 30, pp 90-102, nov 1967. 13 p, 1 fig, 14 ref.

Descriptors: Water rights, \*Farm management, \*Linear programming, Water allocation (Policy), \*Water resources.

Identifiers: Economics, \*Irrigation.

The maximization of the long run social welfare of the community is the dominant goal in water resource use. The optimum allocation of the available water supply on a farm is when the marginal value product of the water applied is equal in all of its uses and greater than or equal to the marginal cost of obtaining the water. Farm management research should be part of the broader framework of macro level studies and decisions. One method of research is to select the geographic boundaries of the study area and analyze the resource problems within the chosen area. Such tools as linear programming and aggregation techniques may then be used. An alternative model would be a simulation model in which variables are estimated by probability distributions and then various decisions are evaluated. (Grossman-Rutgers) W69-00196

# SURFACE WATER RESOURCES PLANNING IN

HUDSON BASIN,
Tippetts-Abbett-McCarthy-Straton, Consulting
Engrs., New York, N. Y. and Div. of Water
Resources, N. Y. State Conservation Dept., Albany, N. Y.

Gerald T. McCarthy, and Nicholas L. Barbarossa.

ASCE Journal of the Hydraulics Division, Vol 94, No 2, pp 375-389, March 1968. 15 p

Descriptors: Hydraulics, New York, Planning, River basin development, Water resources, Water supply, Hudson River, Reservoir sites.

Identifiers: Mohawk River Basin, Water Resources Commission of the State of New York.

A reconnaissance study was made by the consultants for the Water Resources Commission of the State of New York. The objective was to evaluate the quantity and general quality of the ground water and surface water resources within the Hudson-Mohawk River Basin and Long Island. The study assesses the present utilization, analyzes and projects the water needs within a 15,000 sq. mile area, with a present population of 13,000,000 persons, to the year 2020. The entire study area was screened for potential reservoir sites and suitable storage projects were located in the headwater regions. The techniques used to screen potential reservoir sites are described and are believed to have wide application to water resource planning for large river basins. Alternative solutions are developed for municipal water supplies for four regions: (1) Upper Hudson River Basin; (2) Mohawk River Basin; (3) Lower Hudson River Basin; and (4) New York City, West Chester County and Long Island. Special attention is given to water supply problems of New York City and vicinity. The plans presented show relative costs of a number of alternative solutions. (Seneca-Rutgers) W69-00198

# THE SOCIAL VALUE OF WATER RECREATIONAL FACILITIES RESULTING FROM AN IMPROVEMENT IN WATER QUALITY: THE

DELAWARE ESTUARY, Resources for the Future, Inc., Washington. Paul Davidson, F. Gerard Adams, and Joseph Seneca.

In Water Research, Johns Hopkins Press, Baltimore, 1966, pp 175-211, 37 p, 4 fig, 4 tab, 22 ref.

Descriptors: \*Delaware River, \*Recreation facilities, \*Water quality, \*Cost-benefit analysis, Social values, Swimming, Fishing, Boating, Probability, Supply, Benefits, Costs.

Identifiers: \*Water recreation, \*Water recreational facilities, \*Delaware Estuary, Social benefits, So-

cial costs, Market failure.

After analyzing the causes for the failure of markets to provide for outdoor water recreational facilities, the authors performed a benefit-cost analysis of the recreational value of Delaware River water quality improvement. Data from a Public Health Service study was used to estimate a total cost of water quality improvement function. A survey conducted by the Michigan Survey Research Center provided the data for the estimation of empirical relationships between a sizable number of socioeconomic characteristics and the recreational use of water for boating, fishing, and swimming. Projecting the size and characteristics of the population, the demand and marginal benefit functions for water recreation were estimated through 1990. From these estimates an approximation of the optimal level of water quality improvement for recreation was estimated. (Seneca-Rutgers) W69-00205

#### A CASE STUDY IN INCOME REDISTRIBUTION FROM RESERVOIR CONSTRUCTION,

Kentucky Univ., Lexington James L. Douglas.

Water Resources Research, Vol 4, No 3, pp 499-506, June 1968. 8 p, 3 tab, 13 ref.

Descriptors: \*Reservoir construction, \*Flood control, \*Economic efficiency, Cost-benefit analysis, Benefits, Costs, Recreation, Taxes, resources.

Identifiers: \*Income redistribution, \*Flood benefits, \*Recreation benefits, Objective function,
Dewey Reservoir, Weighting factor.

Because water resources investment has been evaluated from the economic efficiency objective, benefit-cost analysis has been criticized as ignoring other goals. Benefit and cost data collected for Dewey Reservoir in the Appalachian Mountains of Eastern Kentucky were used to determine the incidence of benefits and costs among income intervals. Recreation as a project purpose proved more effective in redistributing income than flood control. Weighting the income maximization and income redistribution objectives according to the value judgment that income taxes collected represent equimarginal sacrifice showed income redistribution benefits to equal 18.2% of efficiency benefits. The percentage would be lower in higher income areas. (Seneca-Rutgers) W69-00208

### BENEFIT-COST ANALYSIS: ITS RELEVANCE TO PUBLIC INVESTMENT DECISIONS. Resources for the Future, Inc, Washington, D. C. Arthur Maass.

Water Research, Johns Hopkins Press, Baltimore, 1966, pp 311-328, 18 p, 1 tab, 16 ref.

Descriptors: \*Cost-benefit analysis, Welfare, Economic efficiency.

Identifiers: \*Tradeoff ratio, Public investment, \*Redistribution of income, Objective function, Legislative process.

An evaluation of the branch of welfare economics known as benefit-cost analysis is undertaken. The limitation of benefit-cost analysis is that it ranks projects and programs only in terms of economic efficiency. However, the objective of most public programs is not economic efficiency alone, but additional goals such as redistribution of income and the promotion of national self-sufficiency. Thus, benefit-cost analysis may be largely irrelevant. However, both objectives can be accomplished (efficiency and income redistribution for example) if a tradeoff ratio between efficiency and income redistribution is specified. There is a capacity in the legislative process to make tradeoff decisions. However, the field of public investment for which the present benefit-cost technique is most advanced, water resources, is the field for which political technique for determining tradeoffs between efficiency and other objectives is most primitive. Thus, one should combine benefit-cost analysis with an equally sophisticated technique relating efficiency benefits and costs to those stemming from other objectives. The need for changes in the theory of welfare economics is discussed and evidence is provided that tradeoffs can be determined. (Seneca-Rutgers) W69-00211

#### FEASIBILITY OF WATER EXPORT,

Manitoba Univ, Winnipeg, Canada. Edward Kuiper.

Proc Amer Soc Civil Eng, J Hyd Div, Vol 94, No HY4, 873-891, July 1968. 19 p, 5 fig, 1 tab, 6 ref.

Descriptors: \*Water supply, Desalination, Irrigation, Pumping, Reservoirs, Rivers, \*United States, tion, Pumping, No.
Water resources, Treaties.
\*Canada, \*Water export, British

Identifiers:

This paper reviews the various aspects that are associated with exporting water from one country to another. The general criteria that must be satisfied before export can be contemplated are (1) the exporting country must have a surplus of water; (2) the importing country must have a deficit of water; (3) there must be a mutual advantage in the transfer of water; (4) the two countries must come to an agreement regarding a water export-import treaty. The author describes the application of these criteria to the Canada-United States situation. The continent is divided into three regions: mountain west, prairie, and east. In each region Canada's surplus water in the foreseeable future and the approximate cost of providing it to the United States are calculated. The possibility ap-

### Evaluation Process—Group 6B

pears small that Canadian water export will become economically feasible in the near future. (Seneca-Rutgers) W69-002-13

ENVIRONMENTAL ASPECTS OF RIVER BASIN PLANNING,

North Carolina Univ, Chapel Hill. Maynard M. Hufschmidt.

Proc Amer Soc Civil Eng J Hyd Div, Vol 93, No HY6, pp 323-333, November 1967. 11 p.

Descriptors: Benefit-cost analysis, \*Planning, Environmental effects, Hydraulics, Rivers, Systems analysis, \*Water resources, Administrative agen-

Identifiers: \*Environmental quality.

Current methods, substance, and administration of river basin planning in the United States must be changed substantially to accommodate the increasing national concern for problems of environmental quality. Modifications will be required in planning theory: improvement or environmental quality should be adopted as a major national objective, along with currently accepted objectives of economic efficiency and income distribution. Significant changes are also needed in methods of estimating benefits, cost and production functions, and in the planning process and techniques. Systems analysis methods must incorporate many environmental quality parameters, alternative development estimates and management measures. Planning for river basins and for metropolitan areas must be integrated. Important changes required in water resources policy, organization and adminis-tration are discussed. Extensive research and experimentation on new methods and approaches are required by research centers and public agencies concerned with water resources and environmental quality problems. (Seneca-Rutgers) W69-00214

THE ECONOMIC VALUE OF REAL ESTATE ACQUIRED FOR RIGHT-OF-WAY, Kentucky Univ., Lexington.

L. Douglas James.

Land Economics, Vol 44, No 3, pp 363-370, Aug 1968. 8 p, 1 fig.

Descriptors: \*Right-of-way, \*Land appraisal, Condemnation, \*Cost-benefit analysis, Economic justification, Real property.

A method was developed for estimating the personal value (i. e., value to the owner in excess of what he can realize through market sale) of real estate acquired for water resources development based on statistical analysis of data collected from three reservoirs constructed by the U.S. Army Corps of Engineers. The personal value is the product of the relationship developed over time between the owner and his real property and com-munity. Since this value is real to the owner in that it makes him an unwilling rather than a willing seller and since it is lost through forced sale, lost personal value is a legitimate economic cost and as such should be considered in the economic evaluation of public works projects. (Author) W69-00216

RESEARCH AND DEVELOPMENT RESOURCE ALLOCATION UNDER RIVALRY,

Michigan Univ, Ann Arbor.

F. M. Scherer.

Quarterly Journal of Economics, Vol. 81, No 3, pp 359-394, August 1967. 36 p, 5 fig, 2 tat.

and development. Research Technology, Theoretical analysis, \*Resource allo-\*Competition, Costs, Return, \*Profit, cation, \*Com

Identifiers: Duopoly, Market share, Quality, In-

povation.

Taking into account the development schedules of rival firms and assuming a convex tradeoff between total development cost and development time, this article explores several models of inter-firm rivalry in the development of technically advanced new products. Major results include (1) Cournot-type rivalry leads to more rapid development of new products than either monopolized development or joint profit maximization. (2) The deeper the stream of quasi-rents at stake, the shorter are the minimax, joint profit-maximizing and Cournot equilibrium development schedules and the higher are total development costs. (3) In a broad class of cases, firms with relatively small market shares have stronger incentives to innovate rapidly than dominant firms. However, dominant firms accelerate their development efforts when their market positions are threatened by small innovators, and this action may induce a submissive reaction on the part of the smaller firms. (4) Firms are more apt to accelerate their development efforts in response to rival schedule accelerations when technological leadership can confer permanent market share changes. W69-00218

BENEFIT-COST ANALYSIS AND THE NATIONAL OCEANOGRAPHIC PROGRAM,

Washington Univ, Seattle.

James A. Crutchfield, Robert W. Kates, and W. R. Derrick Sewell.

Also Clara Univ, Worcester, Mass; Victoria Univ, Canada. Natural Resources Journal, Vol 7, No 3, pp 361-375, July 1967. 15 p.

Descriptors: \*Oceanography, \*Planning, \*Costbenefit analysis, Recreation, Benefits, Fisheries, Weather forecasting, Prices, Allotments, Sewage disposal, United States.

Identifiers: National Academy of Sciences, Oppor-

In 1964, a study by the National Academy of Sciences attempted to estimate benefits stemming from oceanographic research over a ten year period and to compare these estimates with the research cost to provide a basis for planning a national oceanographic program. Three basic conceptual weaknesses are evident in the NAS report: (1) in several places, such as in the valuation of outdoor recreation, benefits have either been calculated in gross terms or opportunity costs have been neglected; (2) the study ignores the impact of additional output on prices; (3) the study makes no attempt to define the appropriate composition of the oceanographic program marginal benefit-cost ratios for separable elements ranging from nearly unity to eight are indicative of a serious imbalance. Besides having conceptual weaknesses, the study has serious errors in its estimates of gross benefits. The authors conclude that while a more so-phisticated and conceptually sound benefit-cost analysis of the national oceanographic program would be useful, there remain many areas in which the principal output of the program will continue to be scientific knowledge rather than economic benefits. A purely mechanical application of benefit-cost analysis would be inappropriate. (Seneca-Rutgers) W69-00222

LAKESHORE PROPERTY VALUES: A GUIDE TO PUBLIC INVESTMENT IN RECREATION, Wisconsin Univ, Madison.

Elizabeth L. David.

Water Resources Research, Vol 4, No 4, pp 697-707. August 1968. 11 p, 1 tab, 11 ref.

Descriptors: Recreation demand, Recreation, Water quality, Water pollution, \*Property valued value, Access routes, Lake shores, Swamps, Topogwaite, Access toltage, Surface viaters, Public lands, Water level fluctuations, Wisconsin.

Identifiers: Improvement value, Public investment.

A study of lakeshore property values in which land and improvement values were regressed against at-

tributes of the site and the lake to determine the importance of the various characteristics in predicting property values indicates that swampy or steeply sloped banks are negatively correlated with value. Water quality, proximity to population centers, and the presence of many other lakes in the area are positively related to value. No significant relationships were discovered between land values and the amount of public land in the vicinity or the degree of fluctuation in the lake level. Property values approximately doubled in the ten year period of the study. By suggesting characteristics that seem to be in greater demand, the study provides information to guide some of the decisions about where to spend the limited public budget for waterfront recreational facilities. (Seneca-Rutgers) W69-00227

EXCESS BENEFIT,

Virginia Univ, Charlottesville. Gordon Tullock Water Resources Research, Vol 3, No 2, pp 643-644, Second Quarter 1967. 2 p.

Descriptors: Taxes, \*Water pollution, \*Effluents, Industrial wastes, Legal aspects.

Identifiers: \*Externalities, \*Excess burden, Excise taxes. Subsidies.

If some activity imposes an external cost, then a properly calculated tax on it will reduce the total output of the private sector by less than the revenue received by the government. If the external cost is large, it is possible that the government revenue will be 'free.' This means that the private sector will be as large, or larger, after the tax has been paid. This type of excise tax is clearly the most desirable of all taxes. In most water pollution cases the situation is not this clear but it is still true that gains can be made. A tax on the discharge of effluents by industry into a river produces an excess benefit instead of an excess burden. Indeed it seems likely that taxes on sources of water and air pollution would produce quite considerable revenues, while improving general well-being. Such a tax, if completely unaccompanied by subsidies to people who are injured, may not insure optimum utilization of our natural resources, but it will usually be better than raising the same revenues from taxes that carry substantial excess burdens. (Seneca-Rut-W69-00228

ECONOMIC EVALUATION OF WATER-ORIENTED RECREATION IN THE PRELIMI-NARY TEXAS WATER PLAN,

Texas Agricultural Experiment Station and Texas Techonological College, and Texas Water Development Board. Herbert W. Grubb, and James T. Goodwin.

Texas Water Development Board Rep 84, 28 p, Sept 1968. 4 fig, 3 tab, 7 ref 1 append.

Descriptors: \*Cost-benefit analysis, \*Recreation demand, \*Reservoirs, \*Texas, Statistical methods, Regression analysis, Least squares method, Multiple-purpose projects. Identifiers: Reservoir recreation benefits.

Potential recreation benefits from reservoirs proposed for inclusion in the Texas Water Plan were estimated. Data collected during a 1965 survey of 8 reservoirs were used with population and income data to estimate a recreation visitation prediction equation. A least square regression was fitted to a double logarithmic transformation of the original data. Statistically significant explanatory variables are population, per capita income, cost of travel to reservoirs, proximity of competing reservoirs, and reservoir size. Correlation coefficients, estimated number of visits (1970-2020), and estimated recreational benefits of proposed reservoirs (1970-2020) are tabulated. (Knapp-USGS) W69-00261

## **Group 6B—Evaluation Process**

APPROACHES TO WATER RESOURCE DEVELOPMENT IN CENTRAL AND SOUTHERN FLORIDA, 1845-1947,

Florida Univ, Gainesville, Public Administration

Clearing Service.
John M. DeGrove.

Studies in Public Administration No. 17, pp 1-53, 1958. 13 p, 1 map, 20 ref.

Descriptors: Drainage programs, Irrigation programs, Hydroelectric plants, Municipal water, Industrial water, Land reclamation, \*Water resource development, Multiple-purpose projects, Tennessee Valley Authority Project, Coordination, \*Local governments, Long-term planning, Optimum development plans, \*Federal government, Project planning.

Acute problems in administration, finance, and inter-governmental cooperation present themselves in an interwoven pattern that defies separate analysis. One of the most complicated and vexing illustrations of policy-administration confusion lies in the area of the economic evaluation of water resource projects. The whole question of the economic evaluation of water resource projects has become a sort of political football in which agencies go through an elaborate mathematical exercise to support the pre-conceived fact that they are best suited to develop the project in question. The necessity of developing any major water project within the framework of a federal system further complicates the inadequacies of federal-state-local organization for dealing with the problem. An almost insuperable handicap in attempts to develop effective cooperative patterns which will allow full utilization of the nation's water resources grows out of the administrative dispersion problem at the local, state, and federal level. The pattern since the 1930's may be characterized as one in which a more or less uncoordinated cooperation between federal and state-local agencies. (R. Smith-Fla) W69-00269

# ECONOMIC AND RELATED PROBLEMS IN CONTEMPORARY WATER RESOURCES MANAGEMENT,

New Mexico Univ., Albuquerque School of Law. Allen V. Kneese.

Nat Res J, Vol 5, No 2, pp 236-258, Oct 1965. 22 p. 31 ref

Descriptors: \*Water resources development, \*Administration, \*Water utilization, \*Competing uses, Water allocation (Policy), Water policy, Water conservation, Watersded management, Planning, Water quality, Water requirements, Water supply, Recreation, Water values, Water users.

Problems of allocating existing water supplies among competing demands are taking the place of the problem of developing unused supplies. Economic theory has provided a model of efficient resource allocation for planners. Problems of reallocation of water or water transfers and their ramifications, such as effects on third parties, are discussed. There is a growing problem of estimating the value to be placed upon the use of water for recreational purposes. Water quality appears to be the major national water resource problem in the coming decades. Much additional research is necessary in the area of industries affected by, and causing, water pollution. Additional research into control of flood damage is necessary. Inland navigation, its development and use by such activities as large transportation, should be critically analyzed and compared with alternatives such as pipelines. Research toward achieving optimum efficiency from a system is necessary. The comparative evaluation of present and future benefits and costs from public investments such as water resources management systems is discussed. More appropriate methods of handling the risk and uncertainty associated with water resources projects must be developed. W69-00288

# SOME IMPORTANT RESEARCH PROBLEMS IN THE WATER RESOURCES FIELD,

New Mexico Univ., Albuquerque School of Law. Blair T. Bower.

Nat Res J, Vol 5, No 2, pp 286-297, Oct 1965. 11 p, 10 ref.

Descriptors: \*Project planning, Project purposes, Competing uses, \*Cost-benefit analysis, Multiplepurpose projects, Administration, Benefits, \*Operations research, Water resources development, Project benefits, Analytical techniques.

The article deals with pressing problems of research which will pay off in terms of improved water resources planning and management. The problems of coping with uncertainty stemming from shifting and increasing demands for water and from unpredictable water supplies are discussed. Estimation of hydrologic uncertainty is not the only problem. Flexible water resource systems, analysis of alternative demand patterns over time, changing the end product-time focus of water resources planning, and a system of continuous planning are suggested as procedures for coping with other uncertainties. Study of the relative accuracy of data relating to various types of water resources systems is necessary. Integration is necessary between all authorities dealing with water resources. The problems of planning and developing operating procedures for water resources systems and the evaluation thereof are discussed. Research into the benefits to be derived from various water quality improvements and their value is necessary. Problems such as the relationship between water resources systems and spacial development municipalities, and the benefits from area-wide facilities are discussed. W69-00289

# ORGANIZATIONAL ARRANGEMENTS FOR WATER DEVELOPMENT,

New Mexico Univ., Albuquerque School of Law. Irving Fox, and Lyle E. Craine. Natural Resources J, Vol 2, No 1, pp 1-44, April 1962. 45 p, 34 ref.

Descriptors: \*Administration, Administrative agencies, Administrative decisions, \*Institutions, \*Water resources development, Water policy, Water law, \*Organizations, Long-term planning, Multiple-purpose projects, Planning, Non-structural alternatives, Optimum development plans, Regional analysis, Political aspects, Social aspects, Physical properties.

Identifiers: \*Analytical structure, \*Environmental factors.

This paper takes issue with the assumption of many proposals for organizational improvements in water resources activity that the problem is basically one of overlapping functions and bureaucratic ambitions. The purpose of this paper is to suggest an analytical structure that permits consideration of the problem in terms of fundamental environmental factors. The first part attempts to identify, classify and appraise environmental factors which affect the design of institutional arrangements for water development. This part provides an analytical structure composed of four categories of factors: (1) the value system and its requirements for decision making; (2) the characteristics of the function of producing water services; (3) the significance of relationships among the processes of water development; and (4) the general institutional environment. Part Two explores implications of applying this analytical structure to existing problems of water resources organization. In conclusion, it is hypothesized that there are two interrelated parts in the problems of the analytical structure: (1) finding ways of providing organizational arrangements that are capable of maximizing welfare; and (2) finding ways of motivating water development organizations to maximize welfare. Solutions are offered for both parts of the problem. W69-00296

#### WATER AND LIFE,

Lorus Milne, and Margery Milne. Published by Atheneum, New York, pp 1-257, 1967. 275 p, 54 ref.

Descriptors: \*Water utilization, \*Water conservation, \*Water resources development, \*Water users, Bodies of water, Hydrologic cycle, Rain, Water storage, Environmental sanitation, Water pollution, Cloud seeding, Dew, Forests, Wetlands, Saline water, Desalination, Animals, Sewage, Industrial wastes, Pesticides.

Chapter 1 describes water as a part of the human body, approximately three-tenths of body weight. Chapter 2 encompasses the world's water ways. Navigation, irrigation, consumption by humans, recreation, and flooding are mentioned. Chapter 3 is devoted to the hydrologic cycle. Emphasis is on precipitation and human consumption statistics, as well as water storage, water pollution and sanitation. A revamping of the sewerage system is called for. Pollution is also the topic of Chapter 5 with emphasis on insecticides and industrial wastes. Chapter 6 covers rain, clouds, and cloud seeding. Chapter 7 examines the characteristics and uses of dew. Chapter 8 covers forests. Wetlands are examined in Chapter 9, i.e., an area where water stands for part of the year but in excess of ten feet deep. Chapter 10 discusses salt water and man's ability to cope with saline water problems. Chapter 11 deals with the ability to survive without water with emphasis on the camel. Chapter 12 covers sea exploration and research including desalination. The remaining three chapters examine various characteristics of water, such as its use in dehydrated foods, beautification by statute, and irrigation projects. (Breuel-Fla.) W69-00307

# MANAGEMENT OF WATER RESOURCES FOR REGIONAL DEVELOPMENT,

Dept. of Agriculture, Economic Research Service. Harry A. Steele, and William A. Green. Iowa State University Center for Agricultural and Economic Development, 1966 p 145-65, 9 fig, 22

Descriptors: Market value, Gross national product, Water use, Precipitation, Water requirement, Water consumption, \*River basin development, Water resources development, Project planning, Water supply, \*Future planning, Optimum development plans, Interagency cooperation, \*Federal project policy, Irrigation programs, Long term planning, Short term planning.

Identifiers: Economic base studies, Development need functions.

Explored is the relation of water resources to economic activities, and the application of economic base studies in the formulation of river basin programs. There exists a complicated interrelationship between land and water, which to a large degree affects the growth of the economy. In an attempt to study this a general review is made of the use of the nation's water supply and regional water resources and requirements. It is suggested that investigations be conducted to ascertain pertinent physical and economic information, and that this data be used to form technical and factual guidelines for national water policy. Two major types of investigational efforts are being carried out. The first includes regional studies of water resource problems, while the second deals with selected sub-basin areas. Development-need functions of water resource development are shown with a general outline of necessary elements for the study of drought and irrigation. Potential for water resource development is reviewed and in conclusion a summary of problems and issues is given. (Gargola-Chicago) W69-00390

## Cost Allocation, Cost Sharing, Pricing/Repayment—Group 6C

PUBLICATIONS IN OPERATIONS RESEARCH NO. 3: (ESTABLISHING CRITERIA FOR WATER RESOURCES PROJECTS),

Rand Corporation Research Study, Santa Monica, Calif.

Roland McKean.

Operations Research Society of America, John Wiley and Sons, Inc., 1968, p 103-127, 7 tab, 7 ref.

Descriptors: \*Cost-benefit ratio, Discount rate, \*Annual benefits, \*Annual costs, Assessments, Capital, Capital supply, Cost-benefit analysis, Mar-ket value, Intangible benefits, Intangible costs, Net profit, Operating costs.

identifiers: Net worth, Time streams, Ratio of present values, \*Internal rate of return.

Argued is the validity of examining benefit-cost estimates for government projects with a discussion of difficulties in applying benefit-cost analysis to given projects. The limitations of ratios of annual benefits to annual costs is reviewed. It is concluded that the significant factor is profit on investments or prospective change in present worth; in measuring only gross benefits to costs, certain projects will not be properly assessed. In fact, benefit-cost ratios may be an inherently incorrect criterion for water resource projects. Possible discount rates, another problem of applying benefit-cost analysis, with special time preferences are reviewed. A method for ranking alternatives is outlined, considering that interdependent projects cannot be separately ranked.

Although no single test can point clearly to the set of projects that is optimal, guidelines can be in-dicated and sources of error avoided. (Gargola-Chicago) W69-00392

DEVELOPING AND MANAGING THE WATER

RESOURCES OF N.Y. STATE. New York State Water Resources Comm., Divison of Water Resources.

N.Y. State Water Resources Comm, Div. of Water Res, Albany, N.Y., 1967, 53 p, 14 fig, 24 photo, 3 tab, 1 chart.

Descriptors: \*Water resources development, Interstate commissions, Long-term planning, \*Multi-ple-purpose projects, Municipal water, Water demand, Water management, Recreation demands, Water quality control, Water supply, Navigation, Flood control, \*Resource allocation, \*Optimum development plans, Flood control, \*Reservoir sites,

\*Reservoir operations, Climatic data. Identifiers: New York, N.Y. State Water Res. Comm., Susquehanna River Basin, Oswego River

A review of problems in recreation, lake management, water quality, water supply, flood control, and other areas is given in brief summary for the entire state. To aid in the solution of these problems a general plan is put forth, with the primary objective of providing a framework within which the optimum allocation of water resources can be found. Suggestions for implementing the plan, through coordination of public and private in-terests are presented. Possible sources of financing on the state and local levels are discussed. The first step of the plan is the reservation of reservoir sites which is the substance of the program. Suggestions for additional action in development and management, which could follow, are given. The state is di-vided into three regions and the physical charac-teristics, economic aspects, climate, water supply, and water demand problems of each area outlined. Suggestions for reservoir sites are given with pertinent data for the most promising sites. (Gargola-Chicago) W69-00393

BENEFIT-COST ANALYSIS OF LOCAL A BENEFIT-COST ANALYSIS OF LOCAL WATER SUPPLY,
Louisiana State Univ, Baton Rouge, Economics

Dept. W. J. Stober, and L. H. Falk.

Land Economics, Vol. 39, No. 4, pp 328-335, Nov. 1963, 7 p, 1 fig, 1 tab, 5 ref.

Descriptors: \*Benefit-cost analysis, Benefit-cost ratio, Economies of scale, Capital costs, Interest rate, \*Cost comparisons, Average costs, Tax rate, Diseconomies of scale, Annual benefits, Interest rate, Water development, Municipal water, Water management.
Identifiers: \*Public investment.

The problem of a community faced with a shortage of water for industrial and municipal use is examined. Two courses of action; a private project financed by industry, and a community project, publically financed, are considered within the framework of a benefit-cost analysis. The cost measurement of each is put forth, and in the com-parison the community project emerges as the most economical. This conclusion is a direct result of the corporate income tax structure. A lower cost of capital to the community than to corporate water users has the effect of increasing the benefit-cost ratio. Although a community project is beneficial to the community, it can violate efficiency conditions for the National economy. (Gargola-Chicago) W69-00395

THE DETERMINATION OF RESEARCH NEEDS IN WATER RESOURCE ECONOMICS,

Tennessee Univ., Knoxville, Ctr. for Business and Economic Research. Charles B. Garrison.

OWRR Project No. A-009-TENN, Tennessee, Water Resources Research Center, 1968. 63 p.

Descriptors: Economic research needs, Income redistribution, Regional development, Recreation, Administration.

The project involves a systematic evaluation of water resource economic research needs in Tennessee. The five topics to be considered are: (1) Income Redistribution Effects of Water Resource Programs, (2) Benefits of Metropolitan Waterfront Renewal, (3) Regional Development Benefits of Water-Based Recreation Activities Induced by Reservoir Construction, (4) The Effect of Water Resource Investment Programs on Regional Economic Growth, and (5) The Administration of Water Distribution. Each topic will be evaluated as to specific objectives, scope, methodology and research plan. (Author) W69-00396

## 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

COMPUTERIZED LOCATION MODELS FOR ASSESSING THE IMPACT OF WATER RESOURCE PROJECTS, Washington Univ., St. Louis, Missouri. Institute for Urban and Regional Studies.

Edgar M. Hoover.

In Impact of Water Resources Development on Economic Growth, Working Paper CWR 1, 55 pp, 2 fig, 35 tab.

Descriptors: \*Computer models, \*Computer programs, Resource allocation, Cost comparisons, Economic efficiency, \*Economic evaluation, Economic feasibility, Unit costs, Operating costs. Identifiers: \*Location models.

One of the necessary operations in the overall costbenefit appraisal procedure is to determine how the national location pattern of an industry would be affected by specified reductions in costs of materials extraction, cost of processing, costs of transpor-tation, or material requirements per unit of product. Water resource projects could affect any of these factors. The programs contained in the re-port are designed to evaluate and measure possible effects. Program I determines the optimum pattern of outputs, shipments and sales for the industry and measures its efficiency in terms of total output and average delivered price. Geographical position, costs of producing the material at each source, cost of processing the material at each production location, amount of material required per unit product, parameters of transport cost functions, parameters of demand at various markets are inputs of the program. The procedure followed by the program and impact evaluations are then discussed. Six programs which follow are supplemental variants on the basic program and evaluate the impact of certain single variables. (Gargola-Chicago) W69-00181

# NORTHERN CALIFORNIA'S WATER INDUS-

Resources for the Future.
Joe S. Bain, Richard E. Caves, and Julius Margolis.

In Resources for the Future, Johns Hopkins Press, Baltimore, Md. 1966, pp 347-363, 1 tab, 15 ref.

Descriptors: Water demand, Pricing, \*Water rates, \*Economic justification, \*Marginal costs, Discriminatory pricing, Operating costs, Unit costs. Identifiers: San Francisco Bay Area, Northern California.

Price differentials are employed in the sale of municipal water supplies outside the city. Various reasons are given for this, but none seem totally justified; the pricing structures seem to rest upon faulty analysis. Components of an urban water pricing schedule should include: (1) a fixed charge per period of time, and (2) a quantity charge which covers only incremental operating costs. Unfortunately these principles, and others discussed, are not followed by most municipal pricing systems. Demand and quantity prices which are charged, and arguments for these practices are reviewed. Discrimination through special rates, practiced by many municipal districts, is shown to promote a distortion of water allocation among classes of urban consumers, resulting in prices too low to reflect the long run marginal costs of the typical system. (Gargola-Chicago) W69-00190

## ON THE MARGINAL COST PRICING OF MU-NICIPAL WATER, New Mexico Univ., Albuquerque.

Gilbert W. Bonem.

Water Resources Research, Vol 4, No 1, pp 191-193, February 1968. 3 p, 1 fig, 4 ref.

Descriptors: \*Marginal costs, \*Pricing, \*Municipal water, Water supply, Average costs.
Identifiers: \*Spillover effects, Social benefits, Social optimum, Net benefits, Third party benefits.

It has been maintained that municipal water supply should be priced so that marginal cost equals price. However, there are likely to be 'third party' benefits from some components of municipal water use, primarily from the use of water for landscaping and gardening. Because gardening affects the quality of the urban environment, social benefits may exceed private benefits, and marginal cost pricing may result in a price that exceeds a socially optimal price. The magnitude of divergence of the marginal cost price from the optimal price will depend primarily upon the size of the 'third party' benefits.
(Seneca-Rutgers) W69-00203

### DISCOUNTING AND PUBLIC INVESTMENT CRITERIA,

Resources for the Future, Inc., Washington.

Kenneth J. Arrow. In Water Research, Johns Hopkins Press, Bal-timore, 1966, pp 13-32, 20 p, 37 ref.

Descriptors: \*Discount rate, \*Interest rate, \*Risks, Capital, Investment, Benefits, Costs, Optimization, Taxes, Financing.

## Group 6C-Cost Allocation, Cost Sharing, Pricing/Repayment

Identifiers: \*Public investment, \*Economic growth, \*Imperfect capital markets, Public capital, Private capital, Utility.

The investigation deals with the problem of appropriate discount factors to be applied to the expected streams of benefits and costs generated by public investments. Theoretical problems related to general interest rate questions are discussed. Among them are the problems of imperfect capital markets, the interest rates implied by the growth of per capita consumption and the natural growth rate, the interest rate implications of public investment financing through taxation and borrowing, and the relationship of risk and uncertainty to the level of the appropriate interest rate. Among other things, the paper concludes that public investment policy should be based on a 'myopic rule' (that the present value must be positive), that optimal public investment policy with imperfect capital markets implies two rates of interest (one for private capital and one for public), and that the public sector should not make allowances for risk in choosing among investment alternatives. (Seneca-Rutgers) W69-00204

# THE CALIFORNIA WATER PROJECT: IS PUBLIC DECISION MAKING BECOMING MORE EFFICIENT,

Washington Univ., Seattle, Washington. Gardner Brown, Jr.

Water Resources Research, Vol 4, No 3, pp 463-470, June 1968. 8 p, 27 ref.

Descriptors: \*California, \*Discount rate, Efficiencies, Water supply, Risks, Benefits, Elasticity of demand Desalination Prices

mand, Desalination, Prices. Identifiers: \*Water project, \*Opportunity costs, Investment alternatives, California Water Project, Alternative sources.

It is argued that the use of an incorrect discount rate, the application of procedures that overestimate net benefits, and the failure to charge a scarcity price for water are inappropriate arguments against the value of the California State Water Project. However, the existence of alternative public investment opportunities and technological progress in desalination are two factors to which the State may have given inadequate attention. As a consequence, although the State's water pricing policy encourages more efficient resource allocation than that of the federal government, there are plausible grounds for believing that further improvement is possible. (Seneca-Rutgers) W69-00206

# OPERATIONS RESEARCH APPLIED TO ENGINEERING PLANNING.

Tennessee Technological University, Cookeville. Albert A. Cannella.

Water and Sewage Works, Vol 115, No 7, pp 310-314, July 1968. 5 p, 7 fig, 9 ref, 1 append.

Descriptors: \*Linear programming, \*Operations research, \*Project planning, Interest rate, Growth rates, \*Water distribution (Applied), Water districts, Economic efficiency, Optimum development plans, Digital computers, Costs, Pumping, Design.

Some techniques of Operations Research were applied to a hypothetical water distribution cost minimization problem. Two phases of the problem were treated individually. The Phase I problem was to determine the main trunk line sizes between demand centers in a water district in order to minimize pumping costs. Center to center unit pumping costs were given. A linear programming method was used to find the optimal line routing. The Phase II a non-linear mathematical model was structured and used to find the optimum design periods based on projected demand growths that minimized expansion outlays. The capital outlay, a function of amortization and maintenance cost factors, interest rate, population growth rate, and planning period, was differentiated with respect to the planning period. An iterative process period.

formed on a digital computer was used to solve the resulting equations to find the optimal design period. (Gysi-Cornell) W69-00351

# SENSITIVITY ANALYSIS OF ACTIVATED SLUDGE ECONOMICS, Stanford Univ, Stanford, Calif.

Stanford Univ, Stanford, Calif. Bernard C. McBeath, and Rolf Eliassen. Amer Soc Civil Eng Proc, Vol 92, No. SA 2, pp 147-167, Apr 1966. 21 p, 5 fig, 4 tab, 8 ref.

Descriptors: \*Activated sludge, \*Economics, Analytical techniques, Biochemical oxygen demand, \*Design criteria, Digital computers, Oxygen requirements, Biodegradation, Economies of scale, \*Evaluation, Mathematical studies, Optimization, \*Waste treatment, Economic efficiency, Sludge treatment, Sanitary engineering. Identifiers: \*Sensitivity analysis.

The sensitivity of cost of an activated sludge treatment system to some of the parameters used in its design was tested. The activated sludge process was described in terms of the effects of waste character treatment rates and construction and operational costs. The sensitivity analysis was performed on a computer using first a substitution of values method and then a pair by pair graphic display of cost response to parameter changes for parameters identified as critical. It was concluded that the procedure offered a means of parametric study for the purpose of describing some optimal characteristics of the system, as well as some means of identifying those characteristics. However, it was stated that the procedure gave optimal solutions only when the appropriate parameters were examined within the proper limits. (Gysi-Cornell)

#### 6D. Water Demand

#### LUESSE V WEBER (USE OF LAKE SURFACE).

350 S W 2d 424-432 (Mo 1961).

Descriptors: \*Non-navigable water, \*Navigable water, \*Lakes, \*Barriers, Ownership of beds, Easement, Water utilization, Fishing, Riparian rights, Riparian lands, Water law, Legal aspects.

The plaintiff and the defendant are each owners of laud under and abutting a lake near the Mississippi River. The defendants have a pontoon bridge across the lake on their land. The plaintiff brought suit to have the bridge removed as an obstruction to navigation. The court avoided the question of whether an owner of land covered by a lake artificially raised was entitled to the use of the entire surface of the lake. They held that the lake was not a navigable body of water and that the lake had been divided into portions for the defendant and the plaintiff for 50 years thereby amounting to an acquiescence on the part of the plaintiff. Such acquiescence bars the plaintiff from asserting any right to injunctive relief. (Horner-Fla) W69-00021

### HYDROGEOLOGY AT SHELBYVILLE, IL-LINOIS - A BASIS FOR WATER RESOURCE PLANNING,

Illinois State Geological Survey. For primary bibliographic entry see Field 04C. For abstract, see . W69-00179

# THE LAKE SUPERIOR WATERSHED UNIT. Minnesota State Department of Conservation.

Minnesota Conservation Department Bulletin 24, February 1966, 61 pp, 9 fig, 2 map, 12 tab, 31 ref.

Descriptors: \*Small watersheds, Geology, Topography, Surface water, Ground-water, Water quality, Water pollution.

Identifiers: Lake Superior, Nemadji river, Lake County, Minn., Cook County, Minn., St. Loui County, Minn., St. Lawrence Seaway.

Described are the water resources and wate problems of the Lake Superior watershed unit. This unit is an elongated area which extends for 160 miles along the north shore of Lake Superior. A history of the area, with a review of climate, geology and topography, is given. The economic importance of the mineral resources, soils and forest of the unit are discussed. Reviewed then are the added advantages brought by the St. Lawrence Seaway to the Duluth-Superior harbor, and the potential for future development. General stream flow characteristics are defined and compared; low flow and floods are also discussed. The quality oboth ground and surface water is measured, and the problem of water pollution discussed. Individua sewage systems contribute to ground water pollution, but by far, industrial wastes comprise the major source of pollution. In conclusion, the advantages and problems of the watershed unit are summarized. (Gargola-Chicago)

# SUMMARY OF PRESENT PRACTICES IN EVALUATION OF WATER RESOURCE PROJECTS,

Washington Univ., St. Louis, Missouri. Institute for Urban and Regional Studies.

Raymond J. Struyk.

In Impact of Water Resources Development or Economic Growth, Working Paper CWR 13, 40 pp, 14 ref.

Descriptors: Project planning, \*Cost-benefit analysis, Discount rate, Pollution abatement, Net profit Alternative costs, Direct benefits, Indirect benefits \*Cost analysis, \*Methodology, \*Economic evaluation.

A statement of methods used in estimating future water demands of population, industry, and agriculture with an outline of water quality contro and pollution abatement measures is given. The criteria by which flood control needs and recrea tion resources are examined is reviewed. Projec formulation is carried out on the basis of an ex amination of the above factors, and preliminary study and elimination of alternatives is then done Net worth and alternative worth of each project is compared. Further elimination of alternatives is then carried out. Primary benefits of each project in water quality and supply, recreation, and fish and wildlife, are evaluated. Various approaches to the calculation of these benefits are examined. The evaluation of secondary benefits is then discussed in conjunction with this. General measuremen procedures in cost analysis and the derivation o economic costs are discussed. Methods of progres sive refinement and narrowing of the field of cho ice; screening of alternatives, order of merit ap proach, sub-basin approach, and functional approach, are given in brief summary. (Gargols Chicago) W69-00182

# NORTHERN CALIFORNIA'S WATER INDUSTRY,

Resources for the Future.
Joe S. Bain, Richard E. Caves, and Julius Margolis.

In Resources for the Future, Johns Hopkins Press Baltimore, Md., pp 179-191, 1966.

Descriptors: \*Water demand, \*Elasticity of demand, Pricing, Water rates.
Identifiers: Northern California, San Francisco Batarea.

Domestic or residential, public, commercial, and industrial use form the major components of urbar water use. The determinants of urban demand are those factors which affect the above uses; included are climate, precipitation, income per capita, price per unit and other environmental conditions. Each

omponent of urban water use is affected by these actors to a greater or lesser degree. It is difficult to ain statistical evidence to assess the relative imortance of these factors for many reasons. Cities o not state separately quantities of water denanded by different users. It is difficult to reveal ne response of components of urban demand to hange or difference in price of water, which is ecessary for learning the elasticity of demand for vater. Elasticity of demand plays an important part any economic study and can hold considerable ignificance for both the performance and conduct f the water industry. From this a discussion or ricing, water rates, and interrelationships of the bove factors is given. Low, but significant, elasticies of demand for water are supported, a concluion which has importance in considering the pric-ng systems used by urban agencies which supply vater. (Gargola-Chicago) V69-00188

#### VATER FOR OREGON,

J. S. Geological Survey.

L. N. Phillips, R. C. Newcomb, and H. A. Swenson,

Geological Water-Supply Paper 1649, 1965, 150 p, 47 fig, 35 ref.

Descriptors: Topography, Water table, Water utable, Water utable, Flooding, \*Water supply, \*Water nanagement, \*River basin development, Water al-

dentifiers: \*Oregon river basins.

The rate of flow, quality of water, topography and roundwater resources of Oregon's river basins are liscussed. The severest and most common water problems result from the annual cycle of precipitaion and runoff, causing dry streams in the warmer months and occasions of flash flooding in the rainy eason. Protection against floods should lie in the proper location of towns rather than protective construction while in the dry season pumping of water from distant sources may be necessary. Problems of water purity and pollution are then discussed with suggestions for future development. Although demand is expected to increase as population grows, Oregon should have enough water to supply these demands. It is possible to double or tri-ble the present water supply, and other sources night be developed if necessary. In conclusion, esources to meet future needs are discussed and our basic principles of water resource management put forth. (Gargola-Chicago)
W69-00191

# THE WATER ECONOMY AND ITS ORGANIZA-

FION, New Mexico Univ., Albuquerque School of Law. Vincent Ostrom.

Natural Resources J, Vol 2, No 1, pp 55-73, April 1962. 19 p, 2 ref.

Descriptors: \*Water Allocation (Policy), \*Competing uses, Administrative agencies, Non-consumptive use, Consumptive use, \*Water resources levelopment, \*Planning, \*Multiple-purpose procets, River basin development, Water utilization, \*Area redevelopment, Interstate, \*Tennessee Valey Authority Project, \*Columbia River Basin, dydroelectric plants, Utilities.

Goods and services that are derived from a water supply system can be allocated both by the private narket and by the public economy. For a good to æ amenable to allocation in the market, it must be packageable, 'meaning it can readily be purchased or sold in the market economy. Those not willing to say for the packageable good can be excluded from enjoying its benefits. Most consumptive uses or goods qualify for the exclusion principle. But most n-the-channel or consumptive uses do not qualify for the exclusion principle. The interdependency and competition among water uses militates for a multi-purpose approach. Experience with the Tenessee Valley Authority and in the Columbia Basin has shown that a single integrated agency cannot packageable,' meaning it can readily be purchased

develop comprehensively the resources of a water supply system. A rich and complex system of organization, including a variety of both public and private agencies is needed to gain intelligence, recognize the interdependency among uses, and to mediate the conflicts between competing developers and users. W69-00297

#### RHODE ISLAND WATER PLANNING,

For primary bibliographic entry see Field 06E. For abstract, see . W69-00332

#### STATUS OF WATER RESEARCH IN THE UNITED STATES,

Roland R. Renne

J Am Water Works Ass'n, Vol 60, No 7, pp 749-754, July 1968, 6 p.

Descriptors: Research development, Water resources development, Technology, Grants, Economics, Government finance, Long-term planning, Budgeting, Economic justifications, Federal government, Government finance, Legislation, Standards, Future planning.

There are six types of water problems in the U S: pollution, inadequate supply, uneven distribution, floods, variability of supply and demand, and water treatment. To meet the problems new legislation has launched a 3-way attack of research, planning and development, and quality control. However, too often the tendency is to short change basic research for the future and limit the research funds only to present problems. Federal expenditures for water research have doubled in the past 3 years however this is only 2.5% of federal expenditures for research. The Fed. Council for Science and Technology recommends that research funds be near the \$200,000,000 by 1971. This requires an increase of 20% per year in order to achieve this goal. There are now 38 federal agencies involved in some aspect of water resource activities. One of the key agencies for water research is the Water Resources Scientific Information Center now operating from the Office of Water Resources Research. In looking to the future there are at least restricted or curtailed use, (4) use classifications, (5) improved management of watersheds, (6) desalting, (7) weather modification, (8) importation from other areas. (Kirk-Fla) W69-00333

# EFFECTS OF COMPETITION ON EFFICIENCY

OF WATER USE, Utah State Univ., Dept. of Civil Engineering, Logan

J Irri and Drainage Div (ASCE), Vol 91, No IR 1, pp 69-77, March 1965. 9 p.

Descriptors: \*Water utilization, Arid climates, \*Legal aspects, \*Competing uses, Water demand, Institutional constraints, Irrigation efficiency, Administration, \*Water allocation (Policy), Hydrologic aspects, Interstate compacts, Economic efficiency, Evaporation control. Identifiers: Terminology, Flow systems.

Many factors operate to influence the relation between competition for water and its efficiency of use. Careful attention has to be given to definition of boundaries and terminology if meaningful relations were to be obtained in specific instances. An appreciation for the inter-connection of all natural waters together with their variable and mobile characteristics was needed. Recognition of the effect of legal and institutional mechanisms which tect of legal and institutional mechanisms which modify the relation between competition and water use was required also. Specific examples illustrating both favorable and adverse effects of competition on efficiency of water use were given. The efficiency with which water is used in arid regions is particularly important. (Affleck-Ariz) W69-00380

THE RELATION OF FAMILY INCOME AND USE OF WATER FOR RESIDENTIAL AND COMMERCIAL PURPOSES IN THE SAN FRANCISCO-OAKLAND METROPOLITAN AREA, California Univ, Los Angeles, Water Resources

Center.

Charles J. Headley. Land Economics, Vol. 39, No. 4, p 441-49, Nov. 1963, 8 p, 5 tab, 4 ref.

Descriptors: Time series, Income analysis, \*Elasticity of demand, Water rates, \*Water demand, \*Municipal water, Water supply, Policy matters, Unit costs, Project planning. Identifiers: San Francisco-Oakland Metropolitan

Area, \*Income elasticity, Cross sectional model, Projections.

Defining the determinants of demand for water by urban users is done in a framework which focuses on the relation of family income to demand, holding other variables constant. A time series model and cross-sectional model are used to describe the unique and common features of each of the 12 cities studies. Data on water use, water purchases, and relation to income was gathered and aggregated. From this, projections of the increase in demand are made that are lower than those projected by state agencies. A positive relationship between family income and residential water purchases is demonstrated, while certain differences appear in the elasticity of demand findings of the cross-sectional and time series models. This might indicate under which considerations certain projections should be carried out. In conclusion, it is pointed out that the study is only exploratory and points up many complexities in the entire urban water market. (Gargola-Chicago) W69-00391

# DEVELOPING AND MANAGING THE WATER RESOURCES OF N.Y. STATE. New York State Water Resources Comm., Divison

of Water Resources.

For primary bibliographic entry see Field 06B. For abstract, see . W69-00393

# URBAN DOMESTIC DEMAND FOR WATER: A

KANSAS CASE STUDY, Wisconsin Univ, Milwaukee, Wisconsin. Manual Gottlieb.

Land Economics, Vol. 39, No. 2, pp 204-210, May 1963, 6 pp, 2 fig, 4 tab, 20 ref.

Descriptors: Economies of scale, \*Elasticity of demand, Water rates, Water consumption, Pricing, \*Regression analysis, \*Water demand, \*Municipal water, Water requirements, Economics. Identifiers: Kansas City, Mo., Income elasticity.

Discussed are the demand characteristics for domestic use of purified water produced and distributed by urban water works. Four specific points tributed by urban water works. Four specific points are reviewed; (1) price variance, (2) price elasticity, (3) effect of price change and (4) multiple regression analysis. It is tentatively shown that price elasticity is related to income elasticities, and that a price change temporarily depresses consumption. The actual price elasticity for water on grounds of National and Kansas data is approximately .4 for large cities and .65 for smaller communities. Because of lack of data for overall National and Kansas data is approximately. munities. Because of lack of data for overall National consumption, however, these results cannot be certain. (Gargola-Chicago)
W69-00394

## 6E. Water Law and **Institutions**

RONDESVEDT V RUNNING (OWNERSHIP OF ALLUVION).

19 Wis 2d 614; 121 N W 2d 1-6 (1963).

## Group 6E-Water Law and Institutions

Descriptors: \*Judicial decisions, \*Wisconsin, Riparian rights, \*Accretion (Legal aspects), Water law, Legal aspects, Relative rights, Riparian land.

Plaintiff Rondesvedt and defendant Running both claimed title to the top of a sand point, formed by accretion, which was contiguous only to Rondesvedt's land, but which ran laterally along the shore in front of Running's land. Rondesvedt brought an action to determine title to this land. The court found that if the accretion continued, defendant's access to the deep waters of the lake would eventually be cut off. It then decided that the boundary between the property of Rondesvedt and that of Running should be extended so that it cut across the point and that Running should have title to that portion of the point on her side of the boundary line. On appeal to the Supreme Court of Wisconsin, held, affirmed. The court stated that the general rule that alluvion belongs to the owner of land to which it attaches itself must give away when the rights of other riparian owners would be destroyed by such rule. (R. F. Williams-Fla) W69-00003

#### **BOLLINGER V HENRY (RIPARIAN RIGHTS** ON ARTIFICIAL STREAMS). 375 S W 2d 161-166 (Mo 1964)

Descriptors: Missouri, Judicial decisions, \*Artificial watercourses, \*Riparian rights, \*Prior appropriation, Boundary disputes, Mills, Irrigation \*Ownership of beds. Identifiers: \*Millraces, Adverse possession.

This was an action by owners of a millrace against the owner of adjoining land to quiet title and to obtain an injunction to prohibit the adjoining owner from taking water from the millrace. Several years before this action plaintiffs requested permission from the defendant to alter the millrace. Defendant agreed and a sharp curve in the millrace was eliminated by cutting the millrace through defendant's land. Defendant asserted a right to take water from the millrace at this point. Plaintiffs contended that their use of the millrace was open and notorious for several years and that as such gives them title to the altered section by adverse possession. It was held that plaintiffs had not acquired title to the property, and although the normal rule is that riparian rights do not attach to artificial streams, the rule was altered here. It was held that since the parties had not defined their respective interests in the water, the court could do so, and defendant was allowed reasonable access to the millstream. (Crabtree-Fla) W69-00005

#### KLAIS V DANOWSKI (TITLE TO LANDS UNDER THE GREAT LAKES).

373 Mich 262; 129 N W 2d 414-423 (1964).

Descriptors: \*Michigan, Judicial decisions, \*Riparian rights, \*Accretion (Legal aspects), \*Boundary disputes, Ownership of beds, Great Lakes, Water law, Boundaries (Property), Eminent domain, Riparian land.

This case involved a purchaser's action on a land contract in which the State intervened. The State claimed that the land in question was part of Stateowned, unpatented, submerged lands of the Great bwhed, unparented, submitted and so the Great Lakes and, as such, was subject to legislation providing that occupants on such land may apply to the State for conveyances of its interests. The defendant claimed that the land was patented and hence the statute did not apply. The court agreed with the defendant. Since the land was patented before Michigan's admission into the Union, the U S had no title to pass at that time. The court also held that title of the riparian owner follows the shoreline; and as to accretions, relictions, avulsions or erosions on the Great Lakes, owners of lands bordering on the navigable waters thereof, patented to their ancestors in title by the U S, gain by what comes through accretions and reliction but do not lose that which they own under patent by erosion or avulsion. The right to acquisitions through accessions or reliction was said to be a riparian right, the taking of which by the State requires compensation. (Patterson-Fla) W69-00007

# PARKER V ADAMSON (ARE SAND SLOUGHS WATERCOURSES). 109 Ga App 172; 135 S E 2d 487-491 (1964).

Descriptors: Georgia, Judicial decisions, Boundary disputes, Boundaries (Property), Low water mark, Navigable waters, Non-navigable waters, Lakes, Streams, Ownership of beds, Perennial streams. Identifiers: \*Sand sloughs.

This was an action to determine the true dividing line between two properties in relation to a sand slough. The central issue was whether or not the slough should be considered non-navigable watercourse or whether it was a lake or pond. The boundary line along a non-navigable stream is the center line and along a lake or pond the boundary line is the low water mark. There was evidence that the sand slough was dry several months a year but had water flowing through it to a river during the rest of the year. It was held that the slough was a watercourse and that the center of the stream was the boundary line. Besides evidence as a perennial flow, the court found a slough to be a side channel of a river, and held that the name given a body of water is a material factor in determining its nature. (Crabtree-Fla) W69-00008

#### SCHRODER V BATTISTONI (EASEMENTS TO ERECT DOCKS).

199 A2d 10-13 (Conn 1964).

Descriptors: Connecticut, Judicial decisions, \*Prescriptive rights, \*Easements, \*Docks, Ownership of beds, Lakes, Riparian rights, Recreation, Right-of-water.

This was an action to enjoin interference with plaintiffs' use of docks extending from their property into defendant's lake. Plaintiffs claimed easements to erect and maintain their docks. It was found that their grantor did not intend to convey such an easement, the easements were not necessary for use and normal enjoyment of their lots, and prescriptive rights were not acquired because the dock use was neither adverse nor of sufficient duration. (Crabtree-Fla) W69-00009

# STATE V MAAS AND WALDSTEIN CO. (PRESCRIPTIVE RIGHTS IN NAVIGABLE WATERS).

83 N J Super 211; 199 A 2d 248-254 (1964).

Descriptors: New Jersey, Judicial decisions, Streams, Navigable waters, \*Condemnation, \*Highways, High water mark, \*Ownership of beds, \*Eminent domain, Prescriptive rights, Federal-state water rights conflicts, Riparian rights.

This was a condemnation proceeding to acquire a fee simple in a portion of defendant's lands fronting on the bank of a navigable river. Defendant claimed that the land under the river was not subject to condemnation because: (1) since the condemnation was not in furtherance of navigation and the highway department can only condemn such land for that purpose; (2) federal approval must be obtained for such takings; and (3) defendant had a prescriptive right in fee to the land. Each contention was denied. It was held that federal approval had been acquired, the state had power to condemn, and that title by prescription cannot be obtained against public lands. (Crabtree-Fla) W69-00010

#### WEAVER V KNUDSON (TITLE TO UNMEAN-DERED LAKE SHORE LAND). State of Wisconsin.

23 Wis 2d 426; 127 N W 2d 217-221 (1964).

Descriptors: Wisconsin, Judicial decisions, Shores, Survey, Boundaries (Property), High water mark, Lakes, Riparian land, Ownership of beds, Patents, Identifiers: Meander lines.

This was an action to quiet title. The land in question was conveyed by government patent ac-cording to the official plat. Plaintiffs were grantees of a certain Lot 7 which was split by a large lake. The land in question was a small piece of land across the lake from most of Lot 7. Defendants claimed that while the official plat included the small piece of land, the lake had not been meandered, and under the system then in effect, the patent should be held to include only the larger part of Lot 7. This result was urged because the government would not have intended to convey two unconnected parcels of land as one Lot. It was held that the Government patent should prevail on its face, and title was quieted to plaintiffs. (Crab-W69-00014

#### TRUSTEES OF INTERNAL IMPROVEMENT FUND V TOFFEL (ACCRETION AS IT RE-LATES TO TITLE).

145 So 2d 737-745 (Fla D C A 1962).

Descriptors: Florida, Judicial decisions, Meanders, \*Accretion (Legal aspects), High water mark, \*Surveys, Relative rights, \*Boundaries (Property), Rivers, Prescriptive rights, Riparian land, Public lands, Navigable waters, Ownership of beds. Identifiers: \*Meander line.

This was an action to quiet title to land along the Peace River. The disputed land was the subject of a federal survey in 1849 and was conveyed by patent in 1856. In 1939 the federal government resurveyed the land and claimed that the 1849 survey was invalid as to 386 acres, the land in issue. Plaintiff claimed that the original survey was substantially correct, and that accretion since 1849 accounted for much of the disputed 386 acres. Plaintiff further claimed that unless the surveys were fraudulent or grossly erroneous, that accretion along the navigable river should be his. Defendants claimed title to the 386 acres by patent from the United States after the 1939 survey. They claimed that the 1849 survey was gross error, and that the land in question was never conveyed by the United States under the original patent based on the 1849 survey. It was that the 1849 survey was valid and that accretion since that date accounted for the 386 acres. (Crabtree-Fla) W69-00016

## GIES V FISCHER (BULKHEAD LINES).

146 So 2d 361-364 (Fla 1962).

Descriptors: \*Florida, Judicial decisions, Legislation, Navigation, Cities, \*Ownership of beds, \*Bulkhead line, Local governments, Condemnation, Riparian land, Public lands.
Identifiers: \*Servitudes, Commerce.

This case was a proceeding challenging the constitutionality of Florida Statute 253.122 which authorizes local governments to fix offshore bulkhead lines. The statute was held constitutional. The statute was found to authorize establishment of bulkhead lines only at a point where further outward extension would constitute an interference with the servitude in favor of commerce and navigation. (Crabtree-Fla) W69-00017

## Water Law and Institutions—Group 6E

ORD V TURNER (ACCRETION, AVULSION, AND LAND TITLES).

42 So 2d 335-342 (Fla DCA 1962).

Descriptors: Florida, Judicial decisions, Hur-icanes, \*Accretion (Legal aspects), \*Avulsion, \*Boundary disputes, Navigable waters, Boundaries Property), Islands, Prescriptive rights.

This was an action to quiet title to land formed by accretion along navigable water. It was held that such title is in the owner of the land to which there is an accretion. It was further held that subsequent everance by avulsion would not affect the title of non-submerged lands where such title was established prior to the severance. (Crabtree-Fla) W69-00018

COMMONWEALTH V MAYER (LAKES--LEGAL ASPECTS). 357 S W 2d 879-882 (1962).

Descriptors: \*Kentucky, \*Lakes, Lake beds, Lake bods, Lake bores, State governments, Riparian land, \*Legal aspects, Water law, Reasonable use, Dams, Pernits, Water resources, Recreation, Project puroses. Conservation.

Merchant was granted permission by the Common-wealth of Ky to build a causeway across a neck of the lake wholly on state property but connecting a 21 acre tract which he owned on one side to a 45 acre tract owned by his mother on the other side of the lake. It was provided that Merchant should pay for building and maintaining the causeway, that it must be kept open to the public at all times, and it must be built according to county road standards. The Commonwealth owns both the lake and the access area on each side where the causeway in question is being constructed. The trial court held the causeway created a public nuisance and en-tered judgment ordering the removal of that work which had already been done and permanently enjoining any such project in the future. This court reversed the trial court and held that the fact the appellee's land may be ciminished in value to some extent by the erection of the causeway was not justification of prohibiting its construction. (R. Smith-Fla) W69-00022

JEFFREY V GROSVENOR (ADVERSE POSSES-SION OF RIVER BOTTOM LAND). 157 N W 2d 114-123 (Iowa 1968).

Descriptors: \*Ownership of beds, \*Accretion (Legal aspects), \*Channel flow, Missouri River, \*lowa, Navigable rivers, Riparian rights, Stream beds, Bank erosion, Boundaries (Property), Avul-sion, Bank stabilization, River flow, Islands, Beds, Meanders.

Identifiers: High water mark.

Action was brought to quiet title in plaintiff, the record title holder of Missouri River bottom land. The river by its meandering submerged the land which later reappeared when the river moved by avulsion. The shift of the channel left chutes bounding the property. However, since these were not normal channels, the land failed to conform to the concept of an island as a body of land emerging from a stream and completely surrounding by channels. Application of avulsion principles would require that the river suddenly shift, cutting off a body of land identifiable as property which existed before the shift. In this case the land was completeby submerged, thereby losing its identity. Since the defendant had not held the land by open and continuous possession for 10 years, he could not claim title by adverse possession. (Rives-Fla) W69-00026

DENEERGAARD V DILLINGHAM (LICENSE TO TAKE FROM ANOTHER'S SPRING).

187 A 2d 494-499 (Vt 1963).

Descriptors: \*Vermont, \*Springs, Boundary disputes, Permits, Water law, Legal aspects, Judicial decisions.

The case involved an action for a reformation of the plaintiff's deed to a parcel of land so that three springs would be within its boundaries. The lower court reformed the deed, but included only one of the springs within the plaintiff's property. The court in the instant case upheld the lower court after a review of the facts and the law of reformation of instruments. As to the plaintiff's claim of the existence of a lincense to take water from a spring that was not included within his property, the court held against him. The court stated that a license to take water from a spring can come into being only by the consent of the owner of the land where the spring is located, although consent may be inferred from circumstances indicating tacit consent or acquiesence. However, the plaintiff did not carry his burden of proof in this matter. The decree of the Chancellor was therefore affirmed. (Patterson-W69-00035

GREEN V ELDRIDGE (NAVIGIBILITY TEST IN MARYLAND). 230 Md 441 187 A 2d 674-678 (1963).

Descriptors: \*Maryland, \*Navigable waters, \*Ownership of beds, \*Water law, Watercourses (Legal), Judicial decisions, Boundaries (Property), Marshes, Streams.

Identifiers: Public trust doctrine.

This case involves a suit for an injunction and money damages for making more difficult the construction of a roadway the plaintiff alleged he was struction of a roadway tree plantiff anleged in ewas entitled to build by virtue of a deed from his predecessor in title. It was claimed that the deed conveyed fee simple title to a strip through a creek and marsh upon which the plaintiff desired to construct the road. The Chancellor found that the deed in question granted the plaintiff only an easement; since the creek and marsh were navigable, the bed was owned by the state. The central issue is whether the Chancellor erred in determining the creek and marsh to be navigable. The court in the instant case agreed with the Chancellor. After a review of the cases, the court stated that the waters were navigable under both the old ebb and flow of the tide test and under the more recent navigability in fact test. Traffic of smaller boats was sufficient to establish navigability, since it is not necessary to a stream's being navigable that it be capable of carrying large vessels, or supporting commercial traffic. (Patterson-Fla) W69-00037

STATE V MCDONALD LUMBER (LAKES SHORES). State of Wisconsin.

18 Wis 2d 173; 118 N W 2d 152-154 (1962).

Descriptors: Wisconsin, Lakes, \*Ownership of beds, Excavation, \*Lake beds, Legislation, Landfills, Boundaries (Property), \*High water mark, State governments, Accretion, \*Lake shores, Riparian land, Water law.

The property in question is located at the shoreline of Green Bay just east of the mouth of the Fox River. The city of Green Bay deeded part of this property to the defendant. In 1957, the defendant applied to the Army Corps of Engineers for a permit to construct a dock and slip east of the mouth of the river. The defendant also requested a state permit for this project. Although the Army issued a permit, the state did not. The trial court found the defendant guilty of excavating and filling part of the lake bed without first obtaining permission from the state. The court enjoined the defendant from filling further out into the water but refused. from filling further out into the water but refused to order abatement of the alleged nuisance and also refused to grant an injunction against continuance of unauthorized excavation and trespass. In affirming the trial court, the court held the state had not supported its burden of accurately proving the old shoreline of the lake and was not entitled to injunctive relief. (R. Smith-Fla) W69-00039

STATE V RAYMOND (LEGAL ASPECTS OF ACCRETION)

119 N W 2d 135-140 (Iowa 1963).

Descriptors: Riparian rights, Navigable waters, Ownership of beds, \*Riparian land, Water law, \*Accretion (Legal aspects), \*Islands, Missouri River, High water mark, Iowa, Aerial photography, Charts, Channel improvement, Diversion, Flow control, Vegetation, Iowa.

All the parties to this action agreed that the land in question formed as accretion. The plaintiff claimed it developed in the form of an island that arose in the bed of the Missouri River commencing in 1938.
The defendants contended the property formed as a direct accretion to their riparian lands commencing in 1939, and remained joined to their land until the 1943 flood. The parties did not disagree on the title to land so formed or the rules of law applicable to questions of accretion. The issue before the court was solely a question of fact. The court reviewed the evidence before the trial court and affirmed its decision that the land developed as an island. (R. Smith-Fla). W69-00040

PARISH V SPENCE (SURVEY SHORELINE BOUNDARIES).

149 So 2d 58-65 (Fla DCA 1963).

Descriptors: \*Survey, Water law, Meanders, \*Boundaries (Property), \*Streams, Accretion, Florida, Bayous, Topography. Identifiers: Dependent resurvey.

Plaintiffs have appealed from a summary judgment for defendants. The issue before the court was whether the trial judge erred in ruling that the plat of the 1932 survey, together with the field notes were inadmissible. Defendants contend that the U S Government conveyed title to Lot 6 and 7 in acovernment conveyed tule to Lot 6 and 7 in accordance with the original survey as shown by the 1826 plat. They emphasize that Juniper Creek is delineated on the original plat which affirmatively establishes that no part of Lot 7 lies westerly thereof or westerly of Boggy Bayou which formed a natural boundary between the southern portion of the two lots. It is defendant's position that the purpose and effect of the denonder required of 1923. pose and effect of the dependent resurvey of 1932 is to show an easterly shift in the southerly course is to show an easterly smith in the southerly course of Juniper Creek and a southwesterly recession of Boggy Bayou thereby changing the boundary line between lots 6 and 7. The court set aside the summary judgment and ordered that the dependent resurvey of 1932, and the field notes from which the plat was prepared be admitted into evidence for the surpose of proving the issues in the case. (R. purpose of proving the issues in the case. (R. Smith-Fla) W69-00045

WAGGENER V LEGGETT (TRESPASS TO LAND - DREDGING AND CAVE-IN).

150 So 2d 529-531 (Miss 1963).

Descriptors: \*Mississippi, \*Dredging, \*Damages, Legal aspects, Judicial decisions, Boundaries (Pro-

The plaintiffs brought an action for trespass to land against the defendants, who allegedly dredge soil against the defendants, who allegedly dredge soil from the bottom of a bayou and thereby removed part of the plaintiff's shoreline and caused a cavein. The court in the instant case upheld a ruling of the trial court judge to the effect that where diminution of the permanent value of the land is less than the cost of restoration, an instruction requiring the jury to apply the before-and-after rule, ie, measurement of permanent damages by the difference in the value of the land before and after the trespass, is proper. (Patterson-Fla)

## Group 6E-Water Law and Institutions

W69-00047

LOPEX V SMITH (THE EFFECT OF NAVIGA-BILITY ON BOUNDARY DETERMINATION). 145 So 2d 509-522 (Fla DCA 1962).

Descriptors: Florida, Judicial decisions, Navigation, Navigable waters, \*Boundary disputes, Meanders, \*Surveys, Patents, \*High water mark, Boundary daries (Property).

This was an action to establish ownership of certain island property. The issue was whether the rivers in question were navigable and if so, had been at statehood. It was found that the river had been navigable since statehood, and therefore, boundaries in question were to be determined by highwater marks rather than by meander lines. Navigation was defined in terms of useful purpose, stating that a river is navigable at law if it is navigable in fact. (Crabtree-Fla) W69-00048

## BEDINGFIELD V WATSON (PROPERTY **BOUNDARIES).** 147 So 2d 458-462 (La 1962).

Descriptors: Federal government, State governments, Louisiana, Navigable waters, Water law, \*Boundaries (Property), Lakes, \*Lake shores, Surface waters, Legal aspects, \*Contours, Land, Land

The property in question was located below the 148.6 foot contour line of Lake Bistineau. It was acquired by the State of La upon its admission into the Union as a state, since Lake Bistineau was, in 1812, a navigable stream. The plaintiff alleged ownership of the land in question. The defendants denied this allegation and claimed ownership of the same property on the basis of inheritance from their ancestor-in-title or in the alternative, that they acquired ownership by prescription. The court held that since the defendant's chain originated in a title from the United States Government, it did not extend below the contour line. The defendants claim to the property must therefore, be predicated solely on their plea of acquisitive prescription. The court affirmed the trial court and concluded that the defendants did not establish such possession as owner for the requisite 30 years as would entitle them to acquire title thereto under their plea of prescription. The court held the plaintiffs were the owners of the property in question. (R. Smith-Fla) W69-00049

# THORNHILL V SKIDMORE (EASEMENTS OF ACCESS TO CANALS). 227 N Y S 2d 793-801 (1961)

Descriptors: New York, Judicial decisions, \*Access routes, Recreation, \*Artificial watercourses, \*Canals, \*Easements, Taxes, Right-of-way, Community development, Public rights, Prescriptive Identifiers: Tax title.

This case concerned the plaintiff's right of access to a canal. After first holding that there are no public rights as to an artificially created canal, the court held the purpose of an open area at the end of the canal which was never conveyed out by developer was to afford access to canal to the owners of lots not abutting the canal, and that a tax title conveying such open area to a purchaser at a tax sale from an 'unknown owner' did not operate to relieve the open area of the burden of the easement. (Crabtree-Fla) W69-00050

#### VILLAGE OF OLD FIELD V SCHUYLER (DREDGING STATE SOIL IN RIVER BEDS).

16 A Div 2d 496; 229 N Y S 2d 710-714 (1962).

Descriptors: New York, Judicial decisions, \*Ownership of beds, Permits, \*Dredging, Flood protection, Channel improvement, Beach erosion, State governments, Legislation, Storms, \*Bank ero-

This was a proceeding on a petition to review and annul a license to dredge on state land under water. It was held that the statute authorizing removal of soil from state land under water was intended only to permit an upland owner to improve or protect property or to remedy or prevent shoreline erosion from the action of water or to restore soil washed away by violent storm and consequent avulsion, and that it did not authorize a license to dredge so as to permit a dredging barge to enter to deepen a pond. (Crabtree-Fla) W69-00051

#### SCHULZ V CITY OF DANIA (PRESUMPTION OF EROSION)

156 So 2d 520-522 (Fla D C A 1963).

Descriptors: \*Judicial decisions, \*Florida, \*Avulsion, \*Erosion, Beach erosion, Beaches, Cities, Relative rights, Riparian rights, Oceans, Water law, Legal aspects.

Identifiers: \*Presumption of erosion, \*Burden of proof

Defendant owned a lot originally bounded by the Atlantic Ocean on the east and by plaintiff's land on the west, but which had become submerged under the ocean. Plaintiff city brought a quiet title suit to have vested in itself and its assignee all of the riparian rights incident to its ownership of riparian land. The trial court found that the land had become submerged due to erosion, thereby causing the title to revert to the state, and entered the decree prayed for. Defendant contended on appeal that since the city instituted the suit, the burden of proof was on it to prove that the disappearance took place by erosion, and that this was not satisfied. The District Court of Appeal affirmed the decree, holding that there is a presumption that land disappears by erosion, thereby divesting the owner of title, as opposed to avulsion, not resulting in such divestment. Once plaintiff proved the land had disappeared, the burden shifted to defendant to prove by a preponderance of the evidence that the disappearance was a result of avulsion. (R.F. Williams-Fla) W69-00054

#### CITY OF NORTHLAKE V CITY OF ELM-HURST (PRESCRIPTIVE **RIGHTS:** DISCHARGE OF SEWAGE).

For primary bibliographic entry see Field 04C. For abstract, see W69-00055

DEATON V CAUSEY (SURFACE WATER DRAINAGE - PRESCRIPTIVE PERIOD). For primary bibliographic entry see Field 04C. For abstract, see . W69-00056

# ZABEL V WATER AND NAVIGATION CONTROL AUTHORITY (DREDGE AND FILL PER-MIT REJECTION).

154 So 2d 181-188 (D C A Fla 1963).

Descriptors: \*Florida, \*Water law, \*Administrative decisions, \*Landfills, Riparian rights, Legislation, Dredging, Beds, Permits, Public rights. Identifiers: \*Constitutional law, Public trust doctrine, Sovereignty lands.

Plaintiffs petitioned defendant Pinellas County Water and Navigation Control Authority, pursuant to Florida statutes, requesting that it fix a bulkhead line and grant them a dredge and fill permit for 11.5 acres of their bottom land in Boca Ciega Bay. The Authority refused the permit, and on appeal, a lower court affirmed the Authority's ruling as well as holding that the plaintiffs were estopped from challenging the constitutionality of the statutes under which they were seeking relief. The court in the instant case, after a review of the evidence, held that it was sufficient for the authority to determine that there would be material adverse effects as a result of the proposed fill. Thus there was cause for withholding a permit. The court noted statutes dealing with establishment of bulkhead lines and the Authority's power to regulate dredging and filling. As to the constitutional issue, the court overruled the lower court's holding that plaintiffs were precluded from challenging the constitu-tionality of the operative legislation. However, it upheld the legislation as it was applied in the instant case. (Patterson-Fla) W69-00057

# VAN BROCKLIN V GUDEMA (WELL WATER POLLUTION CAUSED BY NEGLIGENCE OF ADJOINING FARMOWNER).

199 N E 2d 457-462 (111 1964).

Descriptors: \*Water wells, Water pollution, Drainage effects, Surface runoff, Groundwater, Drainage water, Bacteria, \*Water pollution effects, Taste, Illinois, Judicial decisions, Damages, Color.

The litigants owned adjoining farm property. Defendant placed a large pile of manure on his pro-Perty but in close proximity to the plaintiff's well. Rain water passing over the manure contaminated the water in plaintiff's well. Plaintiff and his family lost the use of the well for over eight weeks. He recovered damages for the inconvenience and discomfort caused by the temporary loss of water supply that resulted from the negligence of defendant. The appellate court agreed that inconvenience and discomfort are proper elements of recovery. Evidence of specific pecuniary damage need not be adduced. (Harriett-Fla) W69-00058

# TOWN OF SOMERSET V DIGHTON WATER DIST (LEGISLATION ON DIVERTING WATER SUPPLY). 200 N E 2d 237-240 (Mass 1964).

Descriptors: Public rights, Competing uses, Eminent domain, \*Legislation, Project planning, Governments, Water law, Water rights, Water development, Riparian resources rights, Watersheds (Basins), \*Water supply, Rivers, Surface waters, \*Water wells, Pumping, Massachusetts.

In 1961 the plaintiff, because of an acute need for additional water supplies, initiated several steps to enlarge its water supply by diverting the waters of the Segreganset River to an off-stream reservoir. These steps included the authorization of plaintiff's treasurer to issue bonds in order to raise additional money. However, no formal order of taking of the reservoir land has been made or recorded. Pursant to this plan, the plaintiff entered into an agreement with Montaup to purchase some sixty acres of land in Dighton at the lowest riparian locus to the river. On August 30, 1962, the defendant's commissioners held what they declared to be an emergency meeting to adopt and record an order taking the waters of the Segreganset, before the plaintiff could obtain and record a deed from Montaup and before a restraining order freezing the status quo could be obtained. On the basis of a construction of the word 'appropriated' within the meaning of the Mass statutes, the court held the defendant's purported taking of the waters null and void. (R. Smith-Fla.) W69-00059

WILLIAMS V PENDLETON MFG CO (WATER POLLUTION IN NONNAVIGABLE CREEK). For primary bibliographic entry see Field 05C For abstract, see . W69-00060

T MARY PARISH CO V STATE MINERAL BD MINERAL LEASES OF WATER BEDS). 67 So 2d 509-517 (La 1964).

Descriptors: \*Louisiana, \*Judicial decisions, Beds, leds under water, \*Ownership of beds, Lakes, Vater law, Administrative agencies, Legislation. dentifiers: \*Possessory action, Mineral leases.

This was a possessory action by a land company gainst the state mineral board to be recognized nd maintained in possession of water bottoms in ertain sections. Plaintiff's land was interspersed with water ways and lakes. The purpose of this action is to determine whether plaintiff or defendant as the right to grant mineral leases of the beds of the waters on plaintiff's land. The State of Louiiana was not joined as a party. Plaintiff seeks the enefit of a statute permitting possession of the whole of a tract without actual physical possession only, not ti-le, is before this court.) The court found that laintiff had regularly patrolled the area, granted n electric transmission right of way across the rea, and drilled wells in the area, hence was in posession and entitled to benefit of the statute as to he disputed water bottoms. The court ordered deendant, as agent of the state, to assert any claim of wnership of the bottoms within 60 days. (Kirkconell-Fla) W69-00061

CITY OF DEMOPOLIS, ALABAMA V UNITED STATES (COMPENSATION FOR FEDERAL DAM PROJECTS).

34 F 2d 657-660 (Ct Cl 1964).

Descriptors: \*Judicial decisions, \*United States, Federal government, \*Rivers and Harbors Act, \*Navigation, Compensation, Water law, Legal spects, Rivers, Cities, Sewage disposal, Municipal

Plaintiff was an incorporated city in Alabama which since 1904, had used a gravity sewage system o empty its raw sewage into the Tombigbee River, admittedly navigable. Pursuant to the Rivers and Harbors Act, the defendant Federal Government built a dam downstream from plaintiff city. This rearded the flow of the river and created a lake. The State of Alabama then required plaintiff to build a treatment plant for its sewage. Plaintiff estimated that the cost of such new system would be \$950,052 and sued the Federal Government on the ground that its present system had been seized without compensation. The Court of Claims denied recovery. The rights of a riparian owner are subject to the paramount right of the federal government to improve navigation. This right extends up to the ordinary high water mark, which was above plain-biffs sewage outlet. The court does state that recovery may be had for flooding of municipal land above the high water mark. (R.F. Williams-Fla) W69-00062

BRAUN V FOXBORO CO (DISCHARGE OF SURFACE WATERS).

For primary bibliographic entry see Field 04A.
For abstract, see. W69-00063

BAKER V RINAKER (OBSTRUCTION TO NATURAL FLOW OF SURFACE WATERS). 195 N E 2d 755 (111 1964).

Descriptors: Illinois, \*Surface waters, Streams, \*Obstruction to flow, Natural flow doctrine, Judicial decisions, \*Landfills.

In an action for a mandatory injunction to require defendants to remove a man-made obstruction to the natural flow of water from plaintiff's land wherein defendant counterclaimed to restrain plaintiff from diverting surface water, sustained evidence finding that fill and structures placed on defendants land did not in fact obstruct the natural flow of surface waters from plaintiff's land, and that plaintiff had diverted surface water onto defendant's farm. (Crabtree-Fla) W69-00064

SCOTT V SLAUGHTER (LOWER RIPARIAN RIGHTS V UPPER RIPARIAN RIGHTS). 373 S W 2d 577-580 (Ark 1963).

Descriptors: Arkansas, Hunting, Fishing, Streams, Riparian rights, \*Reasonable use, \*Dams, \*Appropriation, Commercial fishing, Reservoirs, \*Preferences (Water rights), Priorities, Judicial Identifiers: Commercial hunting.

The upper riparian defendant built three dams which lowered the streams flowing through lower riparian plaintiff's land. Defendant and plaintiff operate commercial hunting and fishing facilities on their respective premises. Plaintiff argued that defendant's impoundments constituted an un-reasonable use of the water. Held, the right to use water for domestic purposes is superior to other uses, but other than domestic purposes, all other lawful uses are equal. When one lawful use is destroyed by another lawful use, the second must yield or may be enjoined. However, as in the instant case, reasonable and equitable adjustment may be made. Here, defendant was required to lower the dams partly in order to allow plaintiff enough water to reasonably meet his commercial needs. (Crabtree-Fla) W69-00065

ASSOCIATED CONTRACTORS STONE CO V PEWEE VALLEY SANITARIUM AND HOSPITAL (LIABILITY FOR ALTERING UN-DERGROUND WATERS).

376 S W 2d 316-319 (Ky 1963).

Descriptors: Water pollution, Kentucky, \*Explosions, Underground streams, Percolating water, \*Excavation, Obstruction to flow, Judicial decisions, Reasonable use, Quarries, Rock excavation. Identifiers: \*Nuisance (Legal aspects).

Plaintiff's lands bordered or were close to defendant's property. Defendant planned blasting operations. Plaintiffs objected partly on the grounds that underground streams and percolating waters would be altered and result in damage to plaintiffs. The court found that assuming reasonable and legitimate use, the owner is not liable to adjoining owners for injuries to wells or springs fed by hidden underground streams or percolating waters. The case was decided for plaintiff on other grounds. Crabtree-Fla) W69-00066

GRAVES V WIMPY (COMMUNITY DRAINAGE DITCHES).

372 S W 2d 812-816 (Ark 1963).

Descriptors: Judicial decisions, Arkansas. \*Drainage, Farm management, Repulsion (Legal aspects), \*Ditches, \*Obstruction to flow, \*Permits, Prescriptive rights, Relative rights.

Where adjoining property owners, jointly constructed and used a portion of a drainage ditch from 1954 until 1962, and improvement was accepted and acted upon by both parties in their farming operations, each had a right, in the nature of a license, to the unobstructed use of the community ditch, and plaintiff was estopped from erecting a dam on another portion of the ditch when it had been used by defendant for drainage for four years and when such upper portion of the ditch had been constructed by defendant at his own expense. (Crabtree-Fla). W69-00068

WILLIS V RICH (OBSTRUCTION OF DRAINAGE EASEMENT).

For primary bibliographic entry see Field 04A. For abstract, see . W69-00069

TOWN OF HEMPSTEAD V LITTLE (LIT-TORAL RIGHTS). 20 App Div 2d 539; 245 N Y S 407-410 (1963).

Descriptors: \*Judicial decisions, \*New York, Water law, Legal aspects, \*Condemnation value, Compensation, Cities, \*Eminent domain, Avulsion, Cities, Reliction, Alluvion, Littoral, Beaches, Coasts

In a prior condemnation proceeding, the town acquired title to land owned by the claimants. These lands consisted entirely of uplands, and it was found that the submerged portions had become submerged by avulsion. In the absence of the Town's condemnation, the owners would have retained title to the submerged land if it had once more emerged. When the town condemned the uplands, it also obtained littoral rights, making the fee title of claimants to the submerged lands subject to divestment in the event and to the extent of future alluvion or reliction. Therefore, claimants' unity of title to uplands and submerged lands lost by avulsion was broken when the town obtained the uplands and littoral rights, and an award in this subsequent condemnation suit based on use of several parcels including those to which the town had acquired littoral rights as a single unit was error. (R. F. Williams-Fla) W69-00070

BROWN V ALABAMA POWER CO (BUILDING ENJOINED BY OWNER OF FLOWAGE EASE-MENT).

156 So 2d 153-157 (Ala 1963).

Descriptors: \*Judicial decisions, \*Alabama, Remedies, \*Easements, Water law, Water rights, Flood damage, Real property, Flooding. Identifiers: Flowage easements, Injunction.

The Alabama Supreme Court held that the erection of a house or cottage on land on which a power company owned a flowage easement or an easement to flood the land was rightly enjoined where water would cover a portion of the structure. The holder of an easement has the dominant estate; the owner of the servient estate can be enjoined from performing acts which interfere with the proper enjoyment of the easement. That an obstruction of an easement is of minor degree furnishes no standard for justification if the obstruction clearly interferes with the enjoyment of the easement. (MacMillan-W69-00071

KIDWELL V BAY SHORE DEVELOPMENT CORPORATION (OBSTRUCTION TO FLOW TO SURFACE WATERS).

For primary bibliographic entry see Field 04A. For abstract, see . W69-00072

MILLER V SOMMERS (OBSTRUCTION TO SURFACE DRAINAGE).

For primary bibliographic entry see Field 04A. For abstract, see. W69-00073

PURNELL V HOCK (OBSTRUCTION TO FLOW BY LOWER OWNER).

For primary bibliographic entry see Field 04A. For abstract, see . W69-00074

TOWN OF ASHWAUBENON V PUBLIC SERV COMM'N (BULKHEAD LINES IN NAVIGABLE

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WATERS).

22 Wis 2d 38; 125 N W 2d 647-656 (1964).

Descriptors: Wisconsin, \*Bulkhead lines, Shores, Navigation, Cities, Navigable waters, Judicial decisions, Piers, \*Ownership of beds, State jurisdiction, \*Submerged lands act. Identifiers: \*Trust Theory.

The issue here was the construction of a bulkhead line by a city which would require filling of a navigable river. It was held that the Trust Doctrine pertaining to navigable water does not preclude private structures and fill in beds of navigable rivers where the state legislature has expressly invited such physical interjection. Riparian owners have only qualified title to the beds of navigable rivers and title of the state is paramount; the rights of others are subject to revocation at the pleasure of the legislature. (Crabtree-Fla) W69-00075

# TAYLER V WEST VIRGINIA PULP AND PAPER CO (NAVIGABLE STREAMS).

262 N C 452; 137 S E 2d 833-837 (1964).

Descriptors: \*Judicial decisions, \*North Carolina, Water law, Legal aspects, \*Right-of-way, Easements, \*Condemnation, Navigable rivers, Lumber.

Petitioner was the owner of timberland which was completely surrounded by respondent's tract. Petitioner proceded to ask for condemnation of a cartway leading from his boundary to the respondent's private dirt roads, over which he might carry his timber. Respondent answered that petitioner already owned a right-of-way to a navigable stream, and it also tendered to petitioner the right to use a strip of its land to build a road connecting to a public highway. At trial the judge found that both alternatives open to the petitioner (navigable stream and the offer of an easement) met the requirement of a necessary and proper access to petitioner's land. On appeal to the North Carolina Supreme Court, held, affirmed. Evidence that logs had been transported on the stream ten years prior to this case was adequate to sustain a finding of navigability. If a stream is navigable in fact it is navigable in law, and if such stream provides an adequate means of ingress and egress, the landowner is not entitled to another over the land, even though it may be more economical and convenient. (R. F. Williams-Fla) W69-00076

# BELLVILLE V PORTER (ACCRETION AS IT RELATES TO MAINTENANCE).

For primary bibliographic entry see Field 04A.
For abstract, see .
W69-00077

TIEDEMAN V VILLAGE OF MIDDLETON (SURFACE DRAINAGE BY SUBSURFACE DRAINS).

For primary bibliographic entry see Field 04C. For abstract, see .
W69-00078

# CARVALHO V LEVESQUE (WATER SUPPLY CONTRACTS). 191 A 2d 165-168 (R 1 1963).

Descriptors: \*Rhode Island, \*Water Districts, Easements, Judicial decisions, Supply contracts, Ordinances, Statutes, Water delivery, Administrative decisions, \*Water contracts, Future planning.

The issue here concerned a water districts, while under no obligation to do so, that entered into a water supply contract with plaintiff which provided for future suitable terms; the District subsequently refusing performance unless plaintiff executed a permanent easement to the District unrelated to

plaintiff's water supply. It was held that since the District did not have to supply plaintiff, and in that the District was responsible for future water planning, the requirements of an easement was reasonable. (Crabtree-Fla) W69-00079

WAGNER V TIDEWATER OIL CO (DAMAGE RESULTING FROM STREAM FLOW ALTERATION).

For primary bibliographic entry see Field 04A. For abstract, see . W69-00080

# NORMANOCH ASS'N INC V BALDASANNO (LAKE SHORES).

(LAKE SHORES). 40 N J 113 190 A 2d 852-867 (1963).

Descriptors: Lakes, \*Lake beds, \*Lake shores, Boundaries (Property), Boundary disputes, Legal aspects, \*Ownership of beds, Water law, Dams, Mill dams, Dam construction, Surveys, Mapping, On-site data collections.

This is an appeal by Normanoch from a judgment which dismissed its complaint demanding injunctive relief and damages against defendant for alleged trespass upon certain lands underlying Culvers Lake. Defendant denies Normanoch's title and claims title in himself. The issue was whether the Rutherfurd grant or the Niles deed encompassed the lands in question. The solution to this problem depends on the perimeter of the lake as it existed either at the time of the survey for the Rutherfurd grant on July 31, 1828 or at the recordation thereof on May 23, 1834, as Niles could have only obtained title to those lands which might now be submerged as were excepted from the Rutherfurd grant. Since the ultimate decision depended upon these two chains of title the court outlined the sequence of grants and conveyances. The court concluded that defendant had not presented sufficient evidence to rebut the presumption that the shore boundary had not changed between 1828 and 1882 nor had he disproved that Normanoch had title to the submerged lands. (R. Smith-Fla) W69-00081

## ALLEN V ATLANTA (SURFACE DRAINAGE).

For primary bibliographic entry see Field 04A. For abstract, see . W69-00083

# RECOMMENDED STATE LEGISLATION AND REGULATIONS.

Dept. of Health, Education and Welfare, Public Health Service.

Public Health Service, July 1965, 109 pp, 7 tab.

Descriptors: \*Legislation (Laws), Well regulations, Sewerage disposal, Water supply.

The 'Urban Water Supply and Sewerage System Act' provides for the development of an official community plan for water and sewerage systems consistent with the needs of the area and for the control of installations. The 'Water Well Construction and Pump Installation Act' regulates the development of ground water systems and the location, construction, repair, and abandonment of water wells, and the installation and repair of pumps and pumping equipment to assure protection against possible contamination and to maintain a safe and potable water supply. The 'Individual Sewerage Disposal Systems Act' regulates the design, construction, installation, operation and maintenance of individual disposal systems and the proper planning thereof. The lack of legislation to regulate individual water supply and sewerage disposal in urban areas can create significant public health problems; the study recommends such acts be adopted to facilitate an orderly development of the water supply. (Gargola-Chicago) W69-00177

RIGHTS OF THE STATES IN THEIR NATU RESOURCES PARTICULARLY AS APPL TO WATER, South Carolina Univ., Columbia.

South Carolina Univ., Columbia.
Dudley W. Woodbridge.
S C L Q, Vol 5, No 2-A, pp 130-140, Dec 1952
p, 46 ref.

Descriptors: Water resource development, \*S governments, Interstate, Federal governm \*Federal-state water rights conflicts, Riparights, Equitable apportionment, Relative rights, Clouds, Cloud seeding, Groundwater, Surwater, Ownership of beds, Navigable waters, colating water, Water law.

As a result of the Revolution the people of state became sovereign, and in that capa acquired the rights of the crown in the pu domain. The author describes in detail although the states own their navigable waters ownership is subject to the commerce power, war power, the proprietary property rights, treaty making power, the general welfare powe the federal government, the doctrine of equitapportionment where the stream is an inters one, and to any interstate compacts that have be made as well as the rights of riparian owners. also stated that the ownership of the states' navble waters has a double aspect - the public right the private right. To the extent that a state own navigable waters and the beds of streams in private right it may alien the same as any own But to the extent that a state owns its public right holds in trust for all its citizens and can grant monopoly.

W69-00274

# THE STATUS OF RIPARIAN RIGHTS IN CONECTICUT, Connecticut State Bar Assoc, Hartford.

Connecticut State Bar Assoc, Hartford.
T. Paul Tremont.
Conn B J, Vol 33, No 4, pp 430-439, Dec 1959.
p, 41 ref.

Descriptors: \*Connecticut, \*Riparian rigi \*Docks, Public rights, Ownership of beds, Judie decisions, Riparian land, Water law. Identifiers: \*Shoreland ownership, \*Right to who Public trust doctrine.

In Connecticut, the state owns land between high and low water marks, holding it in trust for people; however, the rights of the individual rip an owner on this land, called franchises, are doubt. The basis of the riparian owner's franchis the right to access, which is usually manifes through the right to erect wharves and piers. In early 1900's, the right to wharf, which was libera interpreted to aid developing economy, was panded to the detriment of the public interest. Case went so far as to hold that riparian rights in soil between the high and low water marks co not be taken for public use without compensati However, the state is now asserting its valid inter in the public shorelands through statute and c law. The author urges that present public pol dictates closer adherence to the public trust d trine.

W69-00275

WATER RIGHTS IN INDIANA.
Indiana State Bar Assoc., Bloomington.

Ind L J, Vol 32, No 1, pp 39-56, Fall 1956. 18 p, ref.

Descriptors: \*Riparian rights, Indiana, \*Water la Water resources development, Legislation.

Indiana water rights law is based on riparian rig doctrine and represents primarily a response of cess rather than water shortage. Comprehens legislation is needed that would delineate priv rights and create procedures for local organizati and a favorable substantive law to encoura storage and other conservation measures. Indian legislative history in the area is discussed. W69-00276

## Water Law and Institutions—Group 6E

RISIS, COMMUNITY AND CONSENT IN VATER POLITICS,

uke Univ, Durham. lenry C. Hart.

aw and Contemp Prob, Vol 22, No 3, pp 510-537, ummer 1957. 28 p, 1 fig, 90 ref.

escriptors: \*Water resources development, Adninistration, Federal-state water rights conflicts, Political aspects, \*Federal government, Governnent finance, River basin development, Planning, State governments, Local governments, Cost haring, Coordination, Multiple-purpose projects, lood control, Dams, Water policy, Reservoirs.

his is a time, as this symposium shows, when many f us can be drawn into a re-examination of our ap-roach to the government of water resources. We have failed to find viable answers to the problems f governing our water resources because we have een looking in the wrong places. We have looked o national departmentalization and executive oranization, while the problem is basically one of public attention and interest. We have looked for ssertions of policy, but the problem is one of iscovering people's conscious needs. We have onceived of techniques as decisive and of the atural flow of water as embodying some human mperative, when its true human meaning is variety and diversity of potential. The water potentials which enlist human enterprise and decision over he years do not coincide, save by remote chance or by the most painstaking institutional arrangenents, with states, cities or the nation. The author hen proposes two alternative plans of future action o solve the above problem. W69-00279

#### REPORT OF THE COMMITTEE ON MARINE RESOURCES.

American Bar Assoc., Chicago, Sect on Mineral and Natural Resources Law.

1967 Committee Reports, pp 226-250, 85 ref.

Descriptors: \*Continental shelf, Continental slope, Ownership of beds, Legislation, Administrative agencies, Submerged Lands Act, Beds, Oceans, State governments, Federal government, Water aw, International law.

Identifiers: \*Truman Proclamation of 1945, \*Convention on the Continental Shelf, Outer Shelf Act.

The report, which covers background material and recent developments in the field of marine resources, is divided into 3 parts: (1) state marine resources; (2) federal resources; (3) international aspects of marine resources. The first part outlines items of interest in state-federal relations, geophysical and leasing activity, court decisions, departmental decisions, regulations and legislation occurring in the Atlantic, Gulf Coast and Pacific states. The second part investigates the Marine Resources and Engineering Development Act as background for 1966-1967 developments in federal marine resources, which include, inter alia, appointments to the Commission on Marine Science in the executive department and passage of the Clean Waters Restoration Act in the legislative branch. The final subdivision of the report focuses on: (1) the Truman Proclamation of 1945, which enunciated the legal concept of the continental shelf; (2) Congressional assertions of jurisdiction through the Submerged Lands Act and the Outer Shelf Act; and (3) the Convention on the Continental Shelf. The Convention defined the continental Shelf. tinental shelf as seabed adjacent to the coast to a depth of 200 meters or, beyond that, to a depth admitting of exploitation of natural resources. W69-00285

JUDICIAL EXPANSION OF SEAWARD BOUN-DARIES ABOVE SUBMERGED LANDS, New York Univ. School of Law, New York

Norman Frost. N Y U Intra L Rev, Vol 16, No 4, pp 235-254, May 1961. 19 p, 84 ref.

Descriptors: \*Submerged Lands Act, Judicial decisions, \*Beds, \*Ownership of beds, Federal government, State governments, Federal jurisdiction, State jurisdiction, Oil fields, \*Continental shelf, Relative rights.
Identifiers: \*Tidelands cases.

In U S v Louisiana and U S v Florida the Supreme Court held that under the Submerged Lands Act, the United States was entitled to all lands, minerals and other resources underlying the Gulf of Mexico more than three geographic miles from the coasts of Louisiana, Alabama, and Mississippi. Florida and Texas were allowed to set their boundaries at 10.5 miles from their coastlines. The Act's provision that a state's boundaries could exceed the three mile limit if they so existed 'at the time' they were admitted to the Union allowed this result. The vast supplies of oil and gas which have been discovered in the continental shelf precipitated the disputes. The 'tidelands' cases, holding that the United States was owner of the three-mile marginal belt, are discussed and criticized. The Submerged Lands Act was passed in 1953 to reverse the result of these cases. The Outer Continental Shelf Lands Act retained jurisdiction over the lands seaward of the state boundaries in the federal government. In conclusion, U S v Louisiana and U S v Florida are W69-00292

REPORT OF THE COMMITTEE ON WATER RESOURCES.

American Bar Assoc., Chicago Sect. of Mineral and Natural Resources Law.

1963 Committee Reports, pp 158-186.

Descriptors: \*Water law, \*Legislation, \*Judicial decisions, \*Administrative decisions, Georgia, Minnesota, Water resources, Federal-state water rights conflicts, Federal government, State governments, Water management (Applied).

The report is divided into three parts, the first dealing with legal developments in the field of water resources in various states and the federal government for the period May 1962 through April 1963. These developments are discussed under the headings of legislation, judicial decisions and administrative action. Among the states reporting are Georgia and Minnesota. Significant federal developments include legislation affecting reclamation projects, coordinated watershed investigations and jurisdiction over interstate river pollution disputes. The second part consists of the first report of the Ground Water Management Subcommittee points out areas of concern that will be more fully developed in subsequent reports. Thirdly, a brief report on legislation relating to federal-state ju-risdictional conflicts in water resources development is given. W69-00298

### REPORT OF THE COMMITTEE ON NATURAL RESOURCES.

American Bar Assoc., Chicago Sect on Mineral and Natural Resources Law.

1965 Committee Reports, pp 136-166, 26 ref.

Descriptors: \*Water law, \*Legislation, Judicial decisions, \*Administrative decisions, Water resources, Minnesota, Federal-state water rights conflicts, Federal government, State governments, Water management (Applied). Identifiers: Water Resources Research Act, Water Pollution Control Act.

The report is divided into three parts, the first dealing with legal developments in the field of water resources in various states and the federal government for the period May 1964 through April 1965. These developments are discussed under the headings of legislation, judicial decisions and administrative action. Although the states reporting are primarily in the western U S, Minnesota is included. Federal developments in the legislative area include enactment of the Water Resources Research Act and the Land and Water Conservation Fund. Among matters pending in the 89th Congress are Federal Water Pollution Control Act amendments, river basin planning proposals, and the Federal Water Projects Recreation Act. Ad-ministrative action taken by the Interior depart-ment and the Federal Power Commission is set forth. The second part consists of the report of the Ground Water Management Subcommittee, and the third treats federal-state water rights action. W69-00299

#### REPORT OF THE COMMITTEE ON WATER RESOURCES.

American Bar Assoc., Chicago Sect of Mineral and Natural Resources Law.

1966 Committee Reports, pp 184-226, 77 ref.

Descriptors: \*Water law, \*Legislation, \*Judicial decisions, Administrative decisions, Minnesota, Illinois, Iowa, Water resources, Federal government, State governments, Water Quality Act, Wild River Act, Water Resources Planning Act.

Identifiers: Water Project Recreation Act, River and Harbor Act.

The report is divided into two parts, the first dealing with legal developments in the field of water resources in various states and the second covering the federal government for the period May 1965 through April 1966. These developments are discussed under the headings of legislation, judicial decisions and administrative action. Although the states reporting are primarily in the western U S, Minnesota, Illinois and Iowa are included. Federal Minnesota, Illinois and Iowa are included. Federal developments in the legislative area include enactment of the Federal Water Project Recreation Act, the Water Resources Planning Act, the Water Quality Act, and the River and Harbor Act. Among matters pending in the 89th Congress are the Wild Rivers Bill and the Colorado River Project. Relevant judicial decisions and administrative action by the Federal Power Commission are set forth.

#### REPORT OF THE COMMITTEE ON WATER RESOURCES.

American Bar Assoc., Chicago Sect of Mineral and Natural Resources Law.

1967 Committee Reports, pp 200-225, 60 ref.

Descriptors: \*Legislation, \*Judicial decisions, Georgia, Iowa, Minnesota, Water resources, Federal government, State governments, Administrative decisions.

The report is divided into two parts, the first dealing with legal developments in the field of water resources in various states and the second covering the federal government for the period May 1966 through April 1967. These developments are discussed under the headings of legislation, judicial decisions and administrative action. Although the states reporting are primarily in the western U S, Minnesota Georgia and lowe are included. Federal Minnesota, Georgia and Iowa are included. Federal developments in the legislative area includes enactment of several bills pertaining to water quality and water management, e. g., a bill creating a Depart-ment of Water Resources and another establishing minimum flows and levels. W69-00301

#### PLEASURE BOATING IN A FEDERAL UNION, **Buffalo Univ**

G. Graham Waite. Buff L Rev, Vol 10, No 2, pp 427-447, Winter 1961. 21 p, 81 ref.

Descriptors: \*Boating, New York, Federal-state water rights conflict, \*Navigation, Ownership of beds, Admiralty, \*Water zoning, Lakes, Inland waterways, Prescriptive rights, Federal government, \*Recreation, Public rights, Interstate.

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Identifiers: Commerce power, Private rights.

This article considers the power to authorize recreational boating on inland waterways and to prescribe standards of conduct on water generally, and the power to zone waters to particular uses. Determination of whether to apply federal or state law in this area generally turns on applications of some concept of navigability. Navigability is some concept of navigability. Navigability is defined for several purposes: (1) ownership of beds of watercourses in new states, (2) public v private rights, (3) waters subject to federal admiralty jurisdiction, and (4) commerce power application. It is suggested that the admiralty test may be expanded to include waters entirely within one state to water the properties of the properties and which are navigable in fact only by motor driven pleasure craft. The conclusion is that control of activity on inland waters in the first instance is in state hands. However, as the activities take on increasing interstate significance, the federal government acquires power to control the activity as well. As to water zoning, New York's policy is examined. The conclusion here is that local or state zoning for certain uses, such as speed, is not an infringement on Federal law. W69-00302

PUBLIC V PRIVATE: THE STATUS OF LAKES, **Buffalo Univ** 

James Munro

Buff L Rev, Vol 10, No 2, pp 459-471, Winter 1961. 13 p, 82 ref.

Descriptors: Minnesota, Wisconsin, Michigan, \*Recreation, \*Access routes, Saw log test, \*Navigation, Federal government, Ownership of beds, Shape, Transportation, Prescriptive rights, Boat launching ramps, Fishing, Hunting, Social

The article deals principally with the use of lakes by the public for recreation. Specifically, it deals with how this issue has been resolved in Minnesota, Wisconsin, and Michigan, with some comments on how other states have dealt with the issue. The view taken is that navigability has been the controlling concept as to whether the public will have access to a lake. However, it is observed that many states have abandoned this principle in favor of common use irrespective of bed ownership or navigability. The historical dilemma centering on whether a state can define navigability differently than the federal government is examined. The importance given to the use of a lake when statehood was conferred is considered as to the relevance of determining navigability today. The article concludes that access by the public where trespass may occur is today's major problem, but, that in general, the law has kept up with the trend toward increasing common use by the public of lakes for recreation.

## APPROPRIATION WATER LAW ELEMENTS IN RIPARIAN DOCTRINE STATES, Buffalo Univ

J. H. Beuscher. Buff L Rev, Vol 10, No 2, pp 448-458, Winter 1961. 11 p, 48 ref.

Descriptors: Wisconsin, Indiana, Ohio, Minnesota, Prescriptive rights, \*Natural flow doctrine, \*Reasonable use, \*Riparian rights, \*Prior appropriation, Domestic water, Water pollution, Public utilities, Preferences (Water rights), Land use, Appropriable waters, \*Appropriation. Identifiers: Coriparians, Dam owners.

The article was based on illustrations drawn largely from Minnesota, Wisconsin, Indiana, and Ohio. It set out in detail the basic differences between riparian and appropriation principles, with a short ripanal and appropriation principles, with a short history of the origins of riparianism. The decline of the natural flow precept was analyzed in terms of the reasonable use doctrine. Several specific devia-tions from pristine riparianism were mentioned in-cluding (1) prescriptive rights, (2) rights of domestic use, (3) dam owners and the rights of coriparians, (4) pollution and correlative riparian rights, (5) municipal water utilities and rights of coriparians, (6) preferences to industrial users, and (7) preferences assured by land use zoning. The article concluded that any description of 'riparian water laws' is far more complicated than would appear from repeated quotations about reasonable use, equality of right, and correlative cosharing. The article ignored the problems raised where navigability must be considered. W69-00305

#### FEDERAL LIMITATIONS ON STATE WATER LAW.

Buffalo Univ

Frank J. Trelease Buff L Rev, Vol 10, No 2, pp 399-426, Winter 1961, 28 p, 162 ref.

Descriptors: \*Federal jurisdiction, \*State jurisdiction, Water resources development, \*Federal-state water rights conflict, Navigation, Wildlife management, Financing, Planning, Public health, Legislation, Project planning.

Identifiers: Treaty power, War power, Proprietary power, General welfare power.

The most important source of federal jurisdiction over water is in relation to navigable waters under the commerce power. The article relates this power to limitations on the power of a state to legislate, limitations on the applicability of state legislation and the effect on state-granted private rights. Other federal powers in this area are mentioned including proprietary powers, war powers, treaty powers, general welfare powers, and the control of interstate relation. The article emphasizes state and federal coordination and cooperation. Specific reference is made to express federal recognition of state water law, corps of engineers projects, Department of Agriculture programs, federal water resource programs, Dept of Interior acquisiton powers, and federal programs concerned with wildlife management and control. The article concludes that the federal government seems to have almost unlimited jurisdiction over water. Where federal and state interests overlap, cooperation is the general rule. The dominance of the United States is due only in part to its constitutional powers; most of it is due to the dominent position of the federal government as financier and planner. (Crabtree-Fla) W69-00306

#### STATE AND FEDERAL WATER LAWS AND CONSIDERATIONS AFFECTING FUTURE AFFECTING FUTURE

LEGISLATION.
North Carolina Board of Conservation and Development, Raleigh.

State and Federal Water Laws and Considerations Affecting Future Legislation, pp 1-151, Jan 1956.

Descriptors: \*North Carolina, \*Legislation, Water law, \*Federal government, Administrative agencies, State governments, Water policy, Riparian rights, Prior appropriation, Judicial decisions, Eminent domain, Regulation, Federal jurisdiction, Navigation, Water pollution control, Flood control, Planning, Irrigation, Reasonable use.

Section One is devoted to North Carolina water laws. Emphasis is on the actual legislation. The relevant statutes are a major portion of the text. Those statutes which create the administrative agencies in North Carolina are included. In addition, comments are provided by interested persons and agencies. Section 2 gives a state by state synopsis of major water laws. Emphasis is on legislation and administrative regulations. Only North Carolina and Hawaii are not covered. Section 3 is devoted to federal laws pertaining to water resources. The areas included are navigation, flood control, multi-purpose planning, water power, stream pollution, reclamation, irrigation, conservation and utilization, watershed protection and flood prevention, beach erosion, sea water and

artificial rainfall. Section 4 deals with some of factors to be considered as affecting future wa legislation. Heavy emphasis is placed on the p appropriation doctrine, its advantages and dis vantages. Alternatives to an adoption of the propriation system are also presented. (Bre-Fla.) W69-00308

#### GEORGIA'S EXISTING WATER LAWS - TI RIPARIAN DOCTRINE. Georgia Univ., Athens

In a Study of the Riparian and Prior Appropriat Doctrines of Water Law, pp 1-18, Oct, 1955. 18 23 ref.

Descriptors: Remedies, Civil law, \*Judicial de sions, Legal aspects, Legislation, Natural flow di trine, \*Riparian rights, Riparian water, Riparland, Water law, \*Georgia, \*Reasonable use, S face waters, Groundwater, Irrigation, Non-navible waters, Diversion, Beneficial use, Water political tion, State governments.

A study of the riparian doctrine as it developed Georgia is presented. Georgia law respecting of fused surface waters, groundwater lakes and ponand non-navigable streams is given in concise for Whether or not a riparian proprietor may put was to a specific use depends on whether or not the u is reasonable. There is no clear criterian, sin reasonableness is a jury question. There is a distin tion between diversion and detention of water.
the case of the former, a lower riparian owner m collect damages whether or not he is actually jured. Injunction and damages are both prop remedies. In the case of the latter, the reasonab ness of the use is the key to whether or not a low riparian owner has a remedy. Specific cases invo ing the application of the riparian doctrine in Gegia are considered and summarized. (Pfeiffer-Fla W69-00313

### FEDERAL JURISDICTION OVER WATER THE EASTERN UNITED STATES,

Michigan State Univ., East Lansing. F. J. Trelease

In Water Rights Conference, pp 1-18, March 2 1960. 18 p, 19 ref.

Descriptors: \*Federal jurisdiction, \*State jurisd tion, Federal government, State governme \*Federal-state water rights conflicts, Water la Legal aspects, Administrative agencies, Legis

The article considers federal jurisdiction of water in relation to state jurisdiction in the fie The sources from which the federal government derives its power are considered, as are the source of state power, and an analysis is drawn in are where the two might conflict. The author then co siders federal programs and how they are set up work with the states. He enumerates the areas which the two governments coordinate a cooperate in their actions. The cooperative a coordinative procedures have been concessions
State and local interests, thus permitting an integrate of governments and the balancing of state a
national interests. The procedures of the fede agencies that have water resource developme programs are designed to give the states a voice those programs. (Horner-Fla.)
W69-00314

# DEVELOPMENT AND ELEMENTS OF THE RIPARIAN DOCTRINE WITH REFERENCE THE EASTERN STATES,

Michigan State Univ., East Lansing.

H. H. Ellis. In Water Rights Conference, pp 19-34, Mar 2 1960. 16 p, 22 ref.

Descriptors: \*Riparian rights, \*Riparian land Watercourses (Legal), \*Water law, Legal aspec

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treams, \*Natural flow doctrine, Reasonable use, /ater utilization.

the author first considers the history of the riparin doctrine. He sets forth the conditions preceeding it and explains its spread. The article then conders the principal elements of the doctrine that are developed over the years. It considers natural and artificial uses, the natural flow doctrine and the assonable use doctrine. The discussion concerns aimly non-navigable watercourses, but it is binted out that the doctrine usually applies to avigable watercourses also. Secondly, the author caces legislative developments in the area and conders their effect on water control. (69-00315

#### OWA'S NEW WATER LAW,

lichigan State Univ., East Lansing.

O'Connol

n Water Rights Conference, pp 54-67, Mar 29, 960, 14 p, 3 ref.

Descriptors: \*Iowa, \*Watercourses (Legal),
Drainage, Water utilization, State governments,
Legislation, Permits, Water law, Legal aspects.

he article discusses Iowa Code Chapter 455A 1958). The law provides for the establishment of a ermit system and a Water Commissioner to adninister the system. The law prohibits the diverion, storage or withdrawal of water for regulated ises from any natural watercourse, underground pasin or watercourse, drainage ditch or settling pasin without a permit from the water commisioner. In addition, no water or material from the urface may be diverted into any underground vatercourse or basin without a permit. The statute numerates the uses of water which are unreguated and therefore require no permit. The author ilso discusses the work of the Pendleton Commitee, which made a comprehensive study and trafted the legislation. W69-00316

### WATER RIGHTS,

Wisc. Univ. School of Law.

H. Beuscher.

College Printing and Typing Co., Madison, Wisc., 1967, pp 1-434, 434 p, 5 map, 3 illus, 35 photo, 4 dwg, 2 tab, 5 chart.

Descriptors: \*Water rights, \*Water law, \*Riparian rights, \*Judicial decisions, Wisconsin, Southeast U.S., Interstate compacts, Prior appropriation, Northeast U.S., Water policy, Pollution abatement, Hydrologic cycle, Surface runoff, Groundwater, Watercourses (Legal aspects), Water allocation (Policy).

dentifiers: Public interests.

This work presents materials used for a course in water law at the University of Wisconsin Law School. The focus of the study is on the law of the eastern states and on the law of Wisconsin in particular, although western appropriation law and western water allocating institutions are also surveyed. Included along with cases are excerpts from law reviews, statutes, compacts, Restatements, and other material. Cases are often supplemented by extensive editorial comments. The major areas included in the study are: (1) water regimes and water law, including a brief study of the hydrologic cycle; (2) the law of diffused surface water; (3) the law of percolating ground water; (4) private rights in watercourses under both the riparian and prior appropriation systems; (5) limitations imposed on private water rights by assertions of public interest; (6) water pollution abatement; and (7) allocations of water between states and interstate water compacts. W69-00317

TAXATION OF LANDS COVERED BY NAVIGABLE WATERS USED FOR COMMERCIAL PURPOSES. State of Florida.

1964 Fla Att'y Gen Rep, No 064-65, May 19, 1964.

Descriptors: \*Florida, \*Taxes, Beds, Navigable water, Riparian land.

The question is whether privately owned lands covered by navigable waters are subject to ad valorem taxation when used by their owners, or under their authority, for commercial purposes. The opinion stated that lands in private ownership are subject to taxation, unless specifically exempted by some provision of the State Constitution, or are held and used exclusively for religious, scientific, municipal, education, literary or charitable purposes, The land in question is taxable unless it falls within some constitutional or valid statutory tax exemption. (Horner-Fla)

# REGULATION OF COASTAL CONSTRUCTION.

State of Florida, Office Attorney General, Tallahassee.

Rep Att'v Gen Fla 065-119, Oct 25, 1965.

Descriptors: \*High water mark, Low water mark, \*Local governments, Riparian land, Public rights, State jurisdiction, \*Florida, \*Intertidal areas, Remedies, Structures, Statutes, Ordinances, Coasts, Riparian rights.
Identifiers: Purprestures, Setback lines.

The sovereign state, in the public interest, may subject a landowner's riparian rights to lawful regulation. Florida, by statute, requires its Board of Con-servation to issue permits for any coastal construction undertaken by a person, firm, corporation etc, upon the sovereignty lands of the state below the mean high water line of any of its tidal waters. The conservation board is similarly empowered by statute to compel the removal of any structure upon such land if it deems it unnecessary, undesirable, serves no public purpose or is dangerous to human life, health or welfare. There is, however, no specific statutory authority by which the Board can regulate coastal construction above the mean high water line on privately owned property, even if such construction would have an adverse effect on public interests. A board of county commissioners likewise has no specific statutory authority to create setback lines on the foreshore of incorporated areas, although such a board may, with the consent of the conservation board and any municipality or other involves political authority, regulate physical work and activities along the county-shoreline. (Geraghty-Fla) W69-00320

#### WATER AND SEWER REGULATIONS. State of Florida, Tallahassee.

Fla Stat Ch 367 (1967).

Descriptors: Water works, Water distribution, Sewage districts, Water law, \*Public utilities, \*Use rates, Water transfer, \*Florida, Administrative agencies.

Section 367.02 defines 'water system,' 'sewer system,' and 'public utility.' Section 367.03.06 provide for the registration and certification of public utilities. Section 367.07 delineates the powers of the Florida Public Services Commission and section 367.01 establishes its jurisdiction. Section 367.08 sets up the limits to which a system may expand and provides procedures for accomplishing such. Section 367.10 provides for the transfer of certificates. Section 367.11 sets forth the duties of a public utility and Sections 367.12 through .16 deal with rates. Section 367.15 further delineates

the powers of the commission and section 367.21 provides that its jurisdiction shall be exclusive. (Dann-Fla) W69-00321

STATE BOARD OF CONSERVATION - WATER RESOURCES DIVISION.

State of Florida, Tallahassee

Fla Stat Ch 373 (1967).

Descriptors: \*Artesian wells, Well regulation, Public benefits, Beneficial use, Average flow, \*Administration, Resources development, Water law, Water districts, Weather modification, Storage, Reasonable use, Easements, Adjudication procedure, \*Saline water-freshwater interfaces, River basins, \*Florida, Administrative agencies, Legislation.

Section 373.021 defines artesian wells and waste. Section 373.031 provides that the flow of artesian wells must be regulated within 90 days after June 15, 1953. Section 373.041 provides that violation of .021 or .031 shall be a misdemeanor. Section 373.051 provides for the capping of unregulated wells by the state and assessment of costs against land owner. Section 373.061 exempts from 373.021-.051 those wells which feed lakes in existence prior to June 15, 1953 where the flow is necessary to the existence of the lake. Section 373.072 (1) declares waters to be a natural resources, (2) vests control in the state and declares policy. Section 373.081 defines various terms for statutory purposes. Section 373.131 sets forth general powers and duties of the Water Resources Division. Section 373.141 authorizes capture, storage and use of water under certain circumstances. Sections 373.141-.182 empower the State Board of Conservation to set up water regulatory districts and provide the administration of same. Section 373.192 provides for annual conferences of water resources development programs. Section 373.193 provides for a representative to the southeast river basins resources advisory board. Sections 373.194-.221 deal with establishing a salt water barrier line. Section 373.321 vests power in the division of water resources to operate within any flood control or water management district. (Dann-Fla) W69-00322

# PLANNING FOR STATE WATER RESOURCES ADMINISTRATION,

Dwight F. Metzler.

AWWA J Vol 58, No 7, pp 793-800, Jul 1966. 8 p, 11 ref.

Descriptors: Administrative agencies, \*Coordination, Decision making, \*Future planning (Projected), Kansas, Long term planning, Programs, \*Resource allocation, State government, Water resources, Administration, \*Planning, Water allocation (Policy).

It has become increasingly important for each state to organize a central program for the allocation, distribution, and quality control of water resources. In order to implement such a program, the state must determine its water needs in sufficient detail to provide guidance to policy objectives. The economic and social water needs of a state may differ substantially from federal needs. Basic economic and population data provides a basis for the allocation of water among several alternative purposes. The state should implement its policy through coordination with agencies of local and federal government. The state should provide tax laws and laws governing the issuance of bonds so that the local governments can deal with their water supply. A legal framework in which one agency is responsible for keeping the legal aspects of the program under continuous study is necessary for the implementation of policies. The responsi-bility for the development of policy and the coordination of the state agencies which collect data, investigate, and enforce laws, should be focused on

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one agency. Kansas has made marked progress using this technique. (Molica-Fla) W69-00327

# POLLUTION CONTROL AND THE FEDERAL POWER COMMISSION,

J. A. Carver.

Natural Resources Lawyer, Vol 1, No 1, p 32-38, Jan 1967. 7 p, 6 ref.

Descriptors: \*Air pollution, \*Water pollution, \*Political aspects, Federal Power Act, Federal government, \*Administrative agencies. Identifiers: Federal Power Commission.

The author considers the responsiveness of the FPC to the problems of air and water pollution that might come within its boundaries. He points out the fields in which the FPC might act in combatting air and water pollution. The general public has a definite interest in the responsiveness of the FPC to pollution problems. The article points out the right of the public to participate in agency decisions and the need for interested citizens to take an interest. Recent court decisions have indicated that the agency must consider all factors brought before it in determining what is the best course of action in light of the public interest. The people have a right to be heard by the commission and it must consider the factors that they might bring before it. (Horner-Fla)

W69-00329

# THE LEGISLATIVE APPROACH TO AIR AND WATER QUALITY,

M. N. Edwards.

Natural Resources Lawyer, Vol 1, No 1, pp 58-69, Jan 1968. 12 p, 16 ref.

Descriptors: \*Water quality, \*Water Quality Act, Air pollution, Water pollution, Planning, Clean Air Act, Federal government, Administrative agencies, State government, Local government, Legislation, Water pollution control, Pollution abatement. Identifiers: Clean Water Restoration Act, Water Pollution Control

The article covers the basic federal legislation dealing with water and air pollution. The federal legislation has placed the primary responsibility for the control and abatement of air pollution on State and local governments. Congress has assumed a role of support and leadership by providing machinery and money; but state and local governments in many instances have not responded as adequately as the problem demands. Congress has provided strong and effective tools for the control of water pollution, but the problems are increasing and both local and federal governments must increase efforts in order to keep pace. (Horner-Fla) W69-00330

# GEORGIA LAWS, POLICIES AND PROGRAMS PERTAINING TO WATER AND RELATED LAND RESOURCES,

Georgia Institute of Technology, Water Resources

G. R. Elmore

Final report Project B-2701, Contract DA-CW55-67-C-001, Water Resources Center, Ga. Inst. of Tech., Atlanta, Ga., June 1967, 123 p, 51 ref.

Descriptors: \*Georgia, \*Legislation, \*Judicial decisions, \*Water law, Planning, Project planning, State government, Water rights, Water policy, Water quality, Administrative agencies, Local government, Water districts, Drainage, Conservation, Water utilization, Financing.

The background and current status of the legislative and organizational framework for the administration of Georgia's water resources are described in the report. Important water- and related land-resource developments are inventoried and a bibliography of important references and data

sources is appended. Information on laws includes pertinent parts of the State constitution, statutes, regulatory measures, and case law as defined by significant court decisions. The administrative structure is outlined in terms of organic laws and administrative actions concerned with powers, duties, procedures and programs. Agencies and organizations covered include State, interstate, special district, and local entities concerned significantly with the management of Georgia's water resources. Agency programs are described, with emphasis on research, data collection, planning, construction, regulation, drainage, irrigation erosion and sedimentation control, and preservation of reservoir sites. (Horner-Fla.)

### RHODE ISLAND WATER PLANNING,

J. H. Chafee.

J Amer Water Works Ass'n, Vol 59, No 4, pp 1213-1216, Oct 1967. 4 p.

Descriptors: \*Rhode Island, River systems, Planning, Project planning, Reservoirs, Legislation, State government, Political aspects, Water storage, Water supply, Future planning (Projected). Identifiers: Regional approach (Planning).

In an address to the Annual Conference of the American Water Works Commission, Governor John Chafee of Rhode Island explained the Rhode Island state-wide approach to water planning. In 1960 a study was prepared by expert consultants which showed three large areas that should be acquired for future reservoirs. Due to political problems only two of the areas had been acquired by 1964 and the third area was not purchased until a drought in 1966 increased the public's awareness of the water shortage problem. A task force was set up to make proposals to the legislature. As a result of the report of the task force, a state-wide water resources board was established to coordinate water projects and to work on long-range water planning. (Horner-Fla) W69-00332

# LEGAL DECISIONS INVOLVING WATER AND WASTEWATER,

For primary bibliographic entry see Field 04A. For abstract, see . W69-00334

# NOR ANY DROP TO DRINK: PUBLIC REGULATION OF WATER QUALITY PART I: STATE POLLUTION CONTROL PROGRAMS.

U of Iowa College of Law, Iowa City, Iowa N. William Hines.

U of Iowa L Rev, Vol 52, No 2, pp 186-235, Oct 1966. 51 p, 259 ref.

Descriptors: \*Water pollution, Non-consumptive use, Consumptive uses, \*Municipal wastes, \*Industrial wastes, Agricultural chemicals, State governments, \*Water law, Judicial decisions, Water pollution control, Water quality control, Public health, Legislation, Pollutants, Water demand, Pollution abatement, Administrative agencies, Organic wastes.

The primary purpose of this first of three articles is to explore state pollution control programs. As a background for this study, the author discusses the scope of the water pollution problem on terms of the demand for water and water quality. In short, a sufficient quantity of water is not the only problem. There is a qualitative problem as well, based on a hierarchy of water demands. The author briefly discusses the major pollution sources: municipal sewerage, industrial waste and agricultural waste. Consideration is also given to the nature of the conflict between private and public interest. The final phase of the background for state regulation is a discussion of the judicial remedies. The author then introduces state regulatory programs. In addition, a section is devoted to the role of public opinion. Following is a study of the constitutional problems in

herent in state control and the limits on the polic power. The final segment is devoted to the state control, including patterns of agencies, the scope c the regulatory power, the creation of standards an their enforcement, and the importance of planning (Breuel-Fla) W69-00335

# WATER POLLUTION - ATTEMPTS TO DECONTAMINATE FLORIDA LAW,

U of Florida, Gainesville, Florida.

Frank E. Maloney, Sheldon J. Plager, and Fletchers N. Baldwin.

U Fla L Rev, Vol 20, No 2, pp 131-157, Fall 1967 26 p, 174 ref.

Descriptors: \*Water pollution, Nuisance (Wate law), \*Pollution abatement, Reasonable use, Stan dards, \*Water quality act, Water quality control Water pollution treatment, Domestic wastes Agricultural chemicals, Industrial wastes Phosphates, \*Legislation, Legal aspects, Federa government, Regulation, Rivers and Harbors Act Florida, Remedies.

Identifiers: 1967 Fla. Air and Water Pollution Control Act, 1965 Model Pollution Control Act Federal Pollution Control Act.

Pollution in Florida arises from domestic, industria and agricultural uses. Reasonable-use rule in Fla imposes liability on pollution which is an unreasonable interference with use of water. Pollution may be attacked on nuisance or trespass theory. Injunction is preferable remedy; balance of convenience doctrine may defeat it. Damages may be given, but are inadequate without injunction because pollution is only compensated for, no prevented. Before 1967 Bd. of Health administered Pollution of Waters Act, approved sewage treatment plants, conducted research and gave technical aid to cities and industries. Local pollution control was under County Water and Sewer, Waste From Mines, and Municipal Zoning Acts. 1967 Florida Air and Water Pollution Control Act transferred regulatory powers of Bd. of Health to specia agency, provided for permit system, and imposees state standards on local programs. 1967 Florida Act is compared with 1965 model act. 1967 act has stronger penalities; both have injunctive relief and civil damages. Federal Pollution Control Act of 1965 provides for abatement proceedings, but wil normally not displace state actions. Plan requires states to establish guide lines, and authorizes funds for construction of sewage treatment plants and federal research grants. (Ausness-Fla) W69-00336

# DIFFUSED SURFACE WATER: SCOURGE OF BOUNTY,

For primary bibliographic entry see Field 04A.
For abstract, see .
W69-00337

#### IOWA'S NEW WATER STATUTE - THE CON STITUTIONALITY OF REGULATING EXIST ING USES OF WATER,

Jeffrey O'Connell. Iowa L Rev, Vol 47, No 3, pp 549-636, Spring 1962. 88 p, 528 ref.

Descriptors: \*Iowa, \*Legislation, Judicial deci sions, Legal aspects, Riparian land, Riparian rights Riparian waters, Usufructuary right, Water law \*Water permits, Water rights, Watercourse (Legal), State governments, Hydrologic cycle Navigable waters, Artificial use, Federal government.

Identifiers: \*Constitutional law, Police power.

The thesis of the article is that provisions of lowa's water rights statute, lowa Code chapter 455 A (1958), regulating existing uses of water (assuming they are regulated) should not render it unconstitutional. The author supports this thesis by a detailed examination of the background of the statute, its terms, prior laws, the need for new legislation, and

legal issues the statute brings forth. The ripariright as a vested right is analyzed, as vested hts are generally protected from legislative privation. It is arguable that the statute does not ect vested riparian rights. The treatment given ter rights legislation by state and federal courts is forth, particular attention being given to the wa Supreme Court and its view of the police wer. The distinction between existing and used rights to water may serve to uphold the con-tutionality of the statute. After summarizing the ture of common-law rights to water, including powers of the state and federal government er water, the reciprocal rights of others, and the ht to capture water, changes brought about by e Iowa statute are examined. (Patterson-Fla) 69-00338

DMPENSABLE VALUES IN FEDERAL ALKING' OF DAMSITES.

r primary bibliographic entry see Field 04A. r abstract, see . 69-00339

# F. Nonstructural

# **Alternatives**

OOD CONTROL ALTERNATIVES AND THE CONOMICS OF FLOOD PROTECTION,

ashington Univ, Seattle.

ater Resources Research, Vol 3, No 2, pp 345-7, Second Quarter 1967. 13 p, 16 ref.

escriptors: Flood control, Flood damage, \*Flood ain insurance, \*Flood plain zoning, Flood proof-g, \*Flood protection, \*Risks, Benefits, Profit. entifiers: \*Safety loading charge, Structural proction, Land enhancement, \*Expected value of sses, Transaction costs.

nis paper discusses and compares the economic fects of alternative programs for coping with ood losses. Special emphasis is placed on the use flood insurance. The measurement of land-shancement benefits is discussed in some detail. everal major conclusions were drawn. First, it is ear that from an economic point of view flood oning is not a desirable method of coping with ood losses. It can only be justified on the grounds political or administrative feasibility, which her programs might lack. Second, flood inrance should be carefully considered as an ingral part of any program for coping with flood sses. Finally, land-enhancement benefits, sses. Finally, land-enhancement benefits, operly measured, represent real gains that should incorporated in benefit estimates. (Seneca-Rut-69-00229

## G. Ecologic Impact of Water Development

## ETERSON V UNITED STATES (ACCRETION).

34 F 2d 664-668 (8th Cir 1967)

escriptors: \*Accretion (Legal aspects), \*Bounda-es (Property), Riparian land, Legal aspects, iparian rights, Banks, Navigable waters, Island, lissouri River, Dams, Reservoirs, North Dakota. lentifiers: Water line.

ction was brought to determine ownership of land ondemned by the U. S. for construction of dam nd reservoir. The disputed land once consisted of lands in the Missouri River. The islands disappared and the land in question formed as accrean to the east bank of the river. The North Dakota atute provided that accretion to the bank of a ver or stream, navigable, belongs to the owner of te bank. Where the water line is the boundary of roperty, that line, no matter how it shifts, remains te boundary. The accretion attached itself to the

mainland and became the property of owners of the land banks to which it accreted. (Rives-Fla) W69-00028

#### STEPHENS V DRAKE (OWNERSHIP OF LAND CREATED BY RIVER CHANGING COURSE).

134 So 2d 674-679 (La 1961).

Descriptors: Louisiana, Judicial decisions, \*Accretion (Legal aspects), Ownership of beds, Wild rivers, River beds, \*River flow, \*Alluvial channels, Channels, Channel flow, Sand bar, Relative rights,

Identifiers: \*Red River, Peninsula.

This action is the result of a dispute as to possession and ownership of land as a consequence of the Red River changing its course. It was held that the owners of land along the east bank of the river as it flowed prior to changing its course did not lose title to a peninsula consisting of alluvion and attached sandbar which had extended into the river from the east bank as the river formerly flowed, by reason of the peninsula's separation from their property when the river changed to a more easterly course. and the owners gained title to the old river bed as well, where the new channel cut through their land. (Crabtree-Fla) W69-00030

# ARIDITY AND SEMI-ARIDITY, A PHYTO-CLI-MATIC CONSIDERATION WITH REFERENCE TO INDIA,

Institut Français, Pondichery, India.

V. M. Meher-Homji. Ann of Arid Zone, Vol 4, No 2, pp 152-158, Sept 1965, 7p.

Descriptors: \*Arid climates, Semiarid climates, \*Ecology, Humidity, Temperature, Precipitation (Atmospheric), Vegetation, Evaporation, \*Classification, Climatic data, Agronomy, \*Geographi-Identifiers: India, \*Aridity.

Bases for classification of arid or semi-arid regions were reviewed. An index of aridity-humidity was proposed based on the ecological formulae of Gaussen. Three principal ecological factors, tem-perature, precipitation and dry periods were con-sidered. Vegetation types were explained on the basis of this index and areas of India were classified according to the developed index. (Affleck-Ariz)

#### 07. RESOURCES DATA

## 7A. Network Design

NEW ASPECTS OF RIVER RUNOFF CALCU-

LATIONS, Pub for U. S. Department of Commerce and Na-tional Science Foundation, Washington, D. C., by Israel Prog for Scientific Transl, Jerusalem. For primary bibliographic entry see Field 02E. For abstract, see . W69-00084

# USE OF ATMOMETERS IN ESTIMATING EVAPOTRANSPIRATION,

California State Department of Water Resources, For primary bibliographic entry see Field 02D.

or abstract, see . W69-00105

## OPTIMIZING SAMPLING INTERVALS, Daniel, Mann, Johnson, and Men DAMOC/WHO, Istanbui, Turkey. Mendenhall, For primary bibliographic entry see Field 05A. For abstract, see .

### 7B. Data Acquisition

DILUTION METHODS OF MEASURING TRANSPORT OF SAND FROM A POINT SOURCE.

Research Station, Wallingford, Hydraulics Berkshire, England. For primary bibliographic entry see Field 02J. For abstract, see . W69-00145

# IN SITU MEASUREMENT OF SOIL SALINITY

WITH A SENSOR, U. S. Salinity Lab., Riverside, Calif. For primary bibliographic entry see Field 02G. For abstract, see. W69-00163

#### FORECASTING THE LEVELS OF THE GREAT LAKES,

U. S. Lake Survey, Detroit, Michigan. For primary bibliographic entry see Field 02H. For abstract, see W69-00202

# RADIOMETRIC STUDIES OF THE FLORIDAN

Florida State Univ., Tallahassee, Florida. For primary bibliographic entry see Field 02F. For abstract, see. W69-00212

# ON THE OPTIMUM RECORDING OF A TYPE

OF HYDROLOGICAL DATA,
Delft Technological Univ, The Netherlands.
M. B. Abbott, E. Pardo Castro, and P. Tas.
Bull Int Ass Sci Hydrol, Vol 12, No 1, pp 44-58,
Mar 1967. 15 p, 14 fig, 6 ref.

Descriptors: \*Hydrologic data, Mathematical models, \*Optimization, \*Sampling, \*Timing, Frequency analysis, Computer programs, Approximation method, Time of concentration, Scheduling, Hydrologic properties, Analytical techniques. Identifiers: Convergence, Difference equations.

An algorithm was developed for finding the optimum spacing of hydrologic data collection, where short periods of intense measurement activity may often be followed by relatively long quiescent periods. The algorithm provided a translation program which resulted in considerable reductions in data collection. It was shown that if the data stream could be represented by a twice differentiable function, that for a particular norm, the second moment of the second derivatives were constant over all op-timum collection intervals. That property was used to construct an iterative difference scheme. Conditions for stability of the scheme were determined and incorporated into a computer program. The program was tested on a variety of data with satisfactory results. A flow diagram of the computer program was shown. Further development of the method was suggested. (Gysi-Cornell) W69-00347

### 7C. Evaluation, Processing **AND Publication**

THE QUALITY OF WATERS PERCOLATING THROUGH STRATIFIED SUBSTRATA, AS PREDICTED BY COMPUTER ANALYSES, California Univ., Water Resources Center, Davis. For primary bibliographic entry see Field 02G. For abstract, see . W69-00164

# COMPUTER SYSTEM FOR THE REDUCTION AND ANALYSIS OF SOIL MOISTURE DATA, Virginia Polytechnic Institute, Blacksburg. V. O. Shanholtz.

OWRR report from Virginia Water Resource Research Center, 1968.

## Field 07—RESOURCES DATA

## Group 7C-Evaluation, Processing and Publication

Descriptors: Data processing, \*Computer programs, Soil moisture, Moisture content,\*Moisture availability.

A system of computer programs, written in Fortran IV for the IBM 7040-1401 system, but readily convertible to other systems, was designed specifically to expedite the reduction and analysis of soil moisture data. The system contains three unique or independent programs for the (1) reduction of basic field data, (2) coding, summary, and plotting, and (3) statistical analysis. Total or available soil moisture for depths of 3 to 6 inch increments up to a maximum of 72 inches can be determined for individual plots or any combination of plots for a given experimental design. The data can be plotted for any combination and/or coded for subsequent statistical analyses. (Shanholtz-VaTech)

# LOW-FLOW INVESTIGATIONS: TECHNIQUES OF WATER-RESOURCES INVESTIGATIONS, U S Geological Survey.

H. C. Riggs.

U S Geol Surv Prelim Rep, 15 p, 1968. 14 fig, 3 tab, 8 ref

Descriptors: \*Low flow, \*Discharge (Water), Hydrographs, Stream gages, Duration curves, Frequency analysis.

Identifiers: Low-flow investigations, Low-flow frequency.

Procedures for defining and evaluating low-flow frequency curves at gaging stations, methods of estimating low-flow characteristics at sites where little discharge information is available, and methods for designing data-collecting systems and reporting results are described. Low-flow characteristics at a gaging station may be described by frequency curves of annual or seasonal minimum flows, by duration curves, and by base-flow recession curves. Ordinarily the characteristics defined at gaging stations cannot be transferred to ungaged sites because low flows are highly dependent on basin geology and evapotranspiration, neither of which can be adequately described, at present, by indexes in a given basin. However, estimates of low-flow characteristics at an ungaged site may be made if a few discharge measurements of base flow during the low-flow season are available. (Knapp-USGS) W69-00245

# COMPUTER SYSTEM FOR REDUCTION AND ANALYSIS OF HYDROLOGIC DATA,

Department of Agriculture, Beltsville, Md., Agricultural Research Service, Virginia Polytechnic Inst., Blacksburg, Virginia. V. O. Shanholtz, and J. B. Burford.

Agricultural Research Service Bull ARS 41-132, July 1967, 90 pp, 9 fig, 29 tab, 4 ref, 10 append.

Descriptors: \*Data processing, \*Data storage and retrieval, Computer models, \*Computer programs, Rainfall, Runoff, Streamflow, Land use, Soil moisture.

A system of computer programs has been developed to handle data related to precipitation, streamflow, temperature, air movement, soil moisture, and land use. Programs are designed to achieve the routine processing, to make certain analyses and summaries, and to select and arrange data in the required format for direct listing on the standard forms, which have been developed for the U.S. Dept. of Agric. Miscellaneous Publication, 'Hydrologic Data for Experimental Watersheds in the United States,' which is a continuing series. The programs are written in Fortran IV for use on the IBM 7040-1401 computer and are designed to accept input information in data card or magnetic tape form with the output on magnetic tape. (Shanholtz-Va Tech) W69-00323

#### 08. ENGINEERING WORKS

#### 8A. Structures

#### A WATER RESOURCE MODEL,

Stanford Univ, Palo Alto, California. For primary bibliographic entry see Field 06A. For abstract, see.

# QUEUEING THEORY AND RESERVOIR DESIGN,

Harvard Univ, Cambridge, Mass. For primary bibliographic entry see Field 06A. For abstract, see . W69-00357

# A MODEL FOR DESIGNING WATER DISTRIBUTION PIPE NETWORKS,

Harvard Univ, Cambridge, Mass.
For primary bibliographic entry see Field 06A.
For abstract, see .
W69-00358

# TECHNIQUES FOR FINDING RESERVOIR OPERATING RULES.

Harvard Univ, Cambridge, Mass. For primary bibliographic entry see Field 06A. For abstract, see . W69-00359

#### 8B. Hydraulics

# ESTABLISHED SURGE ON AN IMPERVIOUS VEGETATED BED.

Div of Agr Eng Services, Agr Tech Services, Republic of S Africa, and California Univ., Davis. W. P. J Wessels, and Theodore Strelkoff.

ASCE Proc, J Irrig and Drainage Div, Vol 94, No IR1, Pap 5832, pp 1-22, Mar 1968. 22 p, 1 tab, 10 fig, 15 ref.

Descriptors: \*Open channel flow, \*Steady flow, \*Surges, \*Irrigation ditches, \*Model studies, Mathematical models, Hydraulics, Water measurement

Identifiers: \*Vegetated bed, Impervious bed, Parallel wire depth gages.

Theoretical and experimental determinations are made of the steady flow of a surge of water onto a dry, impervious bed studded with artificial vegetation-wires protruding through the flow at densities of 7.5, 29 and 116 wires per sq ft. The pertinent differential equation of the flow profile implies movement on a broad front, hydrostatic pressure distribution, no interference between the wakes of the individual resistance elements and constant bottom shear between the elements. Experimental data on profile shape and tip speed are gathered and recorded electrically by a combination of parallelwire resistance probes, a scanner, an a. c. resistance bridge, and Sanborne recorder. Comparison of these data, brought to nondimensional form, with an analytic solution of the differential equation in similar form shows good agreement when the measured tip velocity has decreased from its initial value to within 5% of its terminal value, the flow velocity at normal depth. (Knapp-USGS) W69-00088

#### PHYSICAL PRINCIPLES OF WATER PER-COLATION AND SEEPAGE, Technion-Israel Institute of Technology, Haifa,

Faculty of Civil Engineering.
J. Bear, D. Zaslavsky, and S. Irmay.
UNESCO Arid Zone Research, Series No 29, 465
p, 1968. 14 tab, 291 fig, 546 ref.

Descriptors: \*Hydrology, \*Hydraulics, \*Porour media, \*Percolating water, Unsaturated flow, Saturated flow, Leakage, Seepage, Filtration Hydrodynamics, Models.

Identifiers: \*Flow in porous media, \*Hydrodynamic dispersion, Textbook.

A comprehensive reference and textbook that considers saturated and unsaturated flow of water, immiscible fluids, and miscible fluids through soil rock and other porous media. Unsaturated flow which is extremely complex because of interactions between water, air, dissolved and immiscible contents of water, the various constituents of porous media, and various interfacial tensions, is the cen tral topic covered. Basic equations and assumptions of hydrodynamics are reviewed. Because the subject inevitably involves the fields of oil explora tion, coastal fresh water development, pollution control, well performance, industrial filtration chemical and petroleum engineering, ceramics metallurgy, aeronautical engineering, drying and wetting of materials, and many other hydraulic and hydrologic studies, many fundamentals of fluid movement are covered in detail and illustrated with appropriate figures and equations. Because the book is intended for engineers who have to solve hydrologic and hydraulic problems, heavy empha sis is given to successful mathematical, empirical and other methods for dealing with field situations (Knapp-USGS) W69-00135

#### 8D. Soil Mechanics

# SEEPAGE THROUGH DAMS IN THE COMPLEX POTENTIAL PLANE,

Utah State Univ, Water Research Lab, Logan. Roland W. Jeppson.

ASCE Proc, J Irrig and Drainage Div, Vol 94, IR1 Pap 5835, pp 23-39, Mar 1968. 17 p, 2 tab, 5 fig 15 ref.

Descriptors: \*Seepage, \*Earth dams, \*Boundarie: (Surfaces), Anisotropy, Isotropy, Porosity, Dupuit Forscheimer theory, Darcys law, Digital computers, Approximation method, Fluid mechanics Seepage.

Identifiers: \*Finite difference method.

A method is described of direct procedure for ob taining the solution of seepage through homogeneous isotropic or anisotropic earth dam Solution is obtained by finite differences. The x and y coordinates are considered the dependent varia bles and the velocity potential and the stream func tion the independent variables. Boundary value problems for y and x are formulated in the complete potential plane. Since the size of the flow field in the complex potential plane is unknown from specification of the size and shape of the dam, the final solution is obtained from a cycle of solution each subsequent one of which is obtained in a field of more nearly correct size. Comparisons are given between the coordinates on the phreatic line ob tained by this finite difference method and those obtainable from a solution by the velocity hodo graph. Summarizing the results from a number o solutions of different geometries, a graphical rela tion is given relating the geometric parameters o the dam and the seepage quantity. (Knapp-USGS) W69-00086

DELAWARE COAST, BEACH EROSION CON TROL AND HURRICANE PROTECTION. Army Corps of Engineers, Washington, D. C. For primary bibliographic entry see Field 02L. For abstract, see.

W69-00114

#### MANPOWER, GRANTS AND FACILITIES—Field 09

### Grants, Contracts, and Research Act Allotments—Group 9D

## . MANPOWER, GRANTS AND FACILITIES

D. Grants, Contracts, AND Research Act Allotments

MPILATION OF WATER RESOURCES SEARCH IN SOUTH CAROLINA.

th Carolina Water Resources Advisory Com-

ter Resources Res Inst, Clemson Univ, 38 p, y 1968.

scriptors: \*Data collections, \*Research and relopment, \*South Carolina, \*Water Resources search Act, Water resources, Hydrology, Eneering, Planning, Management. ntifiers: Clemson University.

report on water resources research in South rolina was prepared by the South Carolina tter Resources Advisory Committee. One of the ctions of this committee is to appraise the current level of research activity and to make recommendations on new research that should be initiated. The original manuscript prepared and distributed in 1966 is revised in an effort toward that objective. All Federal and State agencies concerned with water resources were requested to submit a description of the research projects currently being conducted in the State by their agency. A compilation of the project descriptions was submitted. The projects selected for inclusion in the report cover many aspects of the water resources field. However, water-related investigations where the primary objective was directed to plant growth, fish reproduction, etc are not included. The selection was made and categorized according to information by the Federal Council for Science and Technology Committee on Water Resources Research published in 'A Ten-Year Program of Federal Water Resources Research in February 1966. (Knapp-USGS) W69-00255

INVENTORY OF ACTIVE WATER RESOURCES RESEARCH PROJECTS IN NORTH CAROLINA.

Water Resources Research Institute, North Carolina Univ.

North Carolina Univ Water Resources Res Inst Rep 4, 76 p, July 1, 1968.

Descriptors: \*Data collections, \*Research and development, \*North Carolina, \*Water Resources Research Act, Water resources, Hydrology, Engineering, Planning, Management, Fish, Forests, Recreation.

Identifiers: North Carolina University.

An inventory of research projects is updated and reissued annually. All known research projects in North Carolina, including private industry, State and Federal agencies, as well as the senior colleges and universities are listed. Sources of funding, which not shown individually for university research projects, include the Office of Water Resources Research, Federal Water Pollution Control Administration, National Science Foundation, N C Dept of Water and Air Resources, the universities involved, many other agencies, and private industry. The distribution of the research projects by industry, agency, or institution is shown. A total of 267 projects are included. These range in size from major grant or contract work down to graduate thesis research projects with very low levels of financial support. (Knapp-USGS)



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